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For scientists, for students or for the public?
The shifting roles of natural history museums

By Ana Delicado*

Abstract

This article aims to discuss the main roles of natural history museums and to show how these purposes have evolved and adapted throughout the museums' history, as a response to the development of natural sciences and societal change, from their creation in the 18th century to the present. It strives to demonstrate how the balance between research, teaching and disseminating knowledge to the public has successively shifted, without ever forsaking any of these functions. It is focused on Portuguese museums, but examining their place within international trends.

Keywords: museums, natural history, Portugal, public dissemination, natural sciences

Museums are crucial institutions for the study of the history of natural sciences. Natural history museums are among the oldest types of museums and they have been close companions to the emergence and development of the study of nature within modern science.

According to Jan Golinski, 'although its history in relation to the construction of scientific knowledge is only beginning to be written, it is apparent that the museum can claim a significant place on the map of locations in which science has been made. The museum comprises an enclosed setting, but one that can be open up in various ways to the world beyond. It can be adapted to the tasks of education or popularization, but it can also serve as a site of research activity. Arrangement of its contents can signal various conceptions of the order that is believed to exist in the natural world and of the human relationship to it. Museums thus encode and shape particular configurations of knowledge; they display objects but they are never simple windows to the world beyond'.[1]

From its inception, this kind of museum has played three main roles: to host scientific research on the natural phenomena, both by providing material evidence (natural history collections) and institutional sustenance to researchers; to provide support to the training of new professionals; to disseminate scientific knowledge to the wider public. Often, these three roles

have coincided and overlapped, but over the history of natural history museums it is noticeable how each has gained and then lost prominence over the others. The mutations of natural sciences but also of society itself have dictated the transformations in the functions of museums.

This article aims to show how the purposes of natural history museums have evolved and adapted throughout their history, as a response to the development of natural sciences and societal change. Museum activities and statements concerning their mission are used to document these transformations. A particular attention to Portuguese museums is paid, although their connection to international trends cannot be overlooked. The article is divided into loose chronological periods, corresponding to the eighteenth, nineteenth and twentieth centuries.

NATURAL HISTORY, SCIENCE AND MUSEUMS

More so than in any other scientific field, the history of natural sciences and of its museums is closely intertwined. Museums were the core location for scientific research on nature: 'the biological collections of museums and the science that developed from them are the foundation of our understanding of life on Earth'.[2] According to Goodman, 'the natural history museum (…) is and was even more, especially in the nineteenth century, a privileged, legitimated constructor of the natural world. Those within the museum were licensed to speak of the nature - to name it, classify it, construct it – they produced as valorised discourse'.[3]

Although preceded by Van Leeuvenhoek's microscope observations, R. Hooke's 'Micrography' or John Ray, Willoughby and Skippon's naturalist fieldwork, it is Linnaeus's eighteenth century research that is considered the landmark of natural history. His binary and hierarchical system of classification follows a systematic method of precise rules that provided an efficient and universal basis for botany and a necessary preliminary for the theory of evolution.[4]

Foucault's ground-breaking work on the epistemology of the early natural sciences proposes that what distinguishes natural history from former studies and descriptions of plants and animals is a new way of naming things with regard to observation and discourse, documented by 'spaces where things are juxtaposed: herbariums, collections, gardens; the place of this history is an atemporal rectangle, where, devoid of any comment, of all surrounding language, beings are presented next to each other, with their visible surfaces, coming together according to their common traits and by them already virtually analysed and bearers of a single name (…) natural history is nothing more than naming the visible'.[5] Classification is thus

central to natural history, based on systematic observation, on descriptions of the beings according to set criteria, on the verification of likenesses and differences[6]. In order to accomplish this, it is crucial to form series, systematic and comprehensive collections, that gather together specimens that represent what is typical (conformity to norm, representativeness) but also what is 'deviant' (abnormalities, pathological variations).[7] Natural history museums and botanical gardens are thus central to the production of knowledge.

Discovering, describing, classifying and naming unknown species becomes the main activity of naturalists,[8] many of whom are attached to museums. But collecting natural history is also an activity for amateurs. Pomian registers the significant increase in private natural history collections in Paris and Venice between the seventeenth and eighteenth centuries, signalling a 'natural history fashion trend'. Knowledge of natural sciences is disseminated to the general public via books, journals and teaching.

The way objects are disposed in museums reflects dominant theories.[9] Early exhibitions follow closely classification principles, reconstitute the general inventory of living beings, and reproduce the order of books and treaties, functioning 'as a library of preserved specimens'.[10] And although the main purpose of the early natural history museums is scientific research and there is a complete juxtaposition between the scientific object and the museum collection,[11] natural history museums are aimed not just at scientists and connoisseurs, but also to the general public. Museums aim to communicate and disseminate knowledge, by promoting an inteligentibility that is accessible to all. That is manifest in the labelling of specimens and in the promotion of other activities beyond exhibitions, such as lectures and guided visits.[12]

A brief analysis of the first natural history museums in Europe demonstrates the combination of these multiple purposes. The first university collections and botanical gardens date back to the sixteenth century in Italy and Holland, closely connected to the teaching of medicine and pharmacy.[13] But it is the Ashmolean Museum that is considered as the first public museum, which opened in Oxford University in 1683, 'intended for "the knowledge of nature" acquired through the "inspection of particulars"'.[14] Natural objects were displayed according to Payle's Natural Theology, with the aim of 'inducing the mental habit of associating the vision of natural phenomena to the conviction that they are the means of divine manifestation'.[15] Lourenço considers this museum different from pre-existing university collections and teaching museums, since it is aimed at a wider audience and it is truly institutionalised as a museum, with its own structure and personnel.[16] It was located in purpose built facilities and was associated to

a Natural History School and a Chemistry Laboratory, and it provided science teaching until 1860.[17]

The Natural History Museum of Paris stems from the Jardin Royal des Plantes Medicinales, created in 1635 as a rival to Sorbonne's power and to promote the teaching of medicine in French and based on chemical medicine. Essentially a botanical garden, it also held collections of preserved botanical specimens, minerals and 'rare things in nature'.[18] Its main purpose was training, but it was also open to amateurs and to the general public.[19] This orientation was strengthened in the eighteenth century, when it loses its medical specificity, becoming focused on natural history, under the name of Jardin des Plantes and the direction of Buffon, who enlarges the garden and makes public access more regular. The turnout in lectures is so high that a new amphitheatre has to be built.[20] After the French Revolution it becomes a public museum, under the designation Muséum National d'Histoire Naturelle. It is no longer connected to the university and has no formal teaching duties. The government awards it the attributions of conservation, diffusion and research of the collections of the three natural kingdoms.

The British Museum, the first national museum in the world, opened in 1753 with the purpose of promoting 'the manifestation of the glory of God, the confutation of atheism and its consequences, the use and improvement of physic, and other arts and sciences, and benefit of mankind'.[21] Its mixed collections included natural history specimens, some originating from the collections of the Royal Society and overseas expeditions of eminent travellers, such as Captain Cook.

THE FIRST NATURAL HISTORY MUSEUMS IN PORTUGAL

Rómulo de Carvalho[22] attributes the development of natural history in Portugal in the final decades of the eighteenth century both to international influences of naturalists and to the contact with the African, Asian and South American colonies[23]. Portugal is visited by several foreign scientists who publish descriptions of local fauna, such as J. Vigier, Merveilleux and Link, and a few Portuguese collectors assemble natural history cabinets.[24]

The first natural history museum and botanical garden in the country is created by the Royal Household in 1768, with the main purpose of promoting the princes' education.[25] Its first director was the Italian botanist D. Vandelli and the Royal Cabinet of Natural History, later Ajuda Royal Museum, was meant to 'preserve the samples of natural productions from the

colonies and the results of their analysis',[26] and it hosted the collections gathered through 'philosophical voyages' to the colonies of Brazil, Goa, Angola, Mozambique and Cape Verde in 1783, as well as through expeditions in mainland Portugal and the Atlantic islands.[27] According to Brigola, the Museum had 'a strong experimental element connected to the King's overseas strategy', being a 'scientific tool at the service of a strategy for economic development'.[28] Besides scientific and economic functions, the museum and botanical garden also had public enlightenment purposes: from the last decade of the century onwards, it was open to the public once a week and visits by request from aristocrats, natural history enthusiasts, diplomats and foreign travellers were allowed on other days.

Brigola assesses that, although the economic purpose was fairly accomplished, through forestation activities in public gardens, acclimation of valuable species (such as tobacco), medicinal products to the colonies and chemical tests on raw materials for manufacturing companies, the scientific aims fell short of expectations. Vandelli's prolonged absences, an inefficient administrative model, the sheer volume of received products, lack of funds and personnel and the excessive bureaucratic burden imposed on the chief naturalist Alexandre Rodrigues Ferreira determined that few resources were diverted towards scientific work and dissemination. Many collections were left packed in boxes, unstudied and unclassified, 'whose description in scientific publications might have allowed our naturalists to become naming authors'.[29] The educational functions were also compromised: 'the sheer lack of physical space made impossible (or at least difficult) to follow a criterion of systematic display of specimens based on its methodical identification and taxonomical classification'.[30]

The first natural history museum connected to a university was created in 1772 in Coimbra[31], with the constitution of a Faculty 'expressively devoted to the teaching of natural sciences and physical and chemical sciences. It was named Faculty of Philosophy since the subjects taught in those disciplines were considered to belong to the Natural Philosophy, that is to say, the knowledge of science it its diverse aspects'.[32] The statutes of the university prescribed the creation of annex institutions for providing support to teaching, among which a Natural History Museum and a Botanical Garden: 'Being manifest that nothing can contribute more to the advancement of Natural History than the continuous viewing of the objects it comprises, which produces ideas more filled with strength and truth than all descriptions, even the most exact, and figures, even the most perfect, it is necessary, in order to grip, in a dignified way, the study of Nature at the core of the University, to create a collection of the products that belong to the three kingdoms of the same nature (…) we must take care to seek to make the said

collection in the most comprehensive way possible e to enrich it with the new products of Nature that can be found both in its regular functioning and in its monstrous one'.[33]

The University Statutes also prescribed the physical requirements for displaying the museum collection (three rooms devoted to the three kingdoms) and to organise the botanical garden, making mandatory to give prominence to medicinal plants (the garden was shared with the Faculty of Medicine) and plants from overseas dominions. There was to be a detailed catalogue of the collection and the Natural History Professor was to be also in charge of the museum and garden.[34] This position was filled by D. Vandelli, who also sold his private collection to the university. The museum would also receive the legacy of José Roleen Van-Deck, remittances from the Ajuda Museum and colonial authorities, purchases from collectors and commercial houses, assortments gathered by University naturalists.[35] The collections were inventoried, classified and displayed in order in the rooms allocated to the museum in 1775.[36] However, the number of students in the Philosophical course was low and their professional careers thwarted: 'the fashion for amateur collecting among the elites, the social interest in the study of nature (…) and the acceptance of its economic usefulness by rulers did not have the proportional correspondence in the professional careers and the filling of administrative positions for which the naturalists would be disciplinary suited'.[37]

The last of the eighteenth century museums was created within the Academy of Sciences with the justification that a collection of natural specimens, 'as long as well ordered, can result in the advancement of the arts, commerce, manufacture and all branches of economy',[38] but also to provide support to the lessons in natural history.[39] In 1781 the Academy publishes a leaflet entitled 'Brief instructions to the correspondents of the Academy of Sciences of Lisbon on the remittances of products and news pertaining the History of Nature in order to form a national Museum', a list of rules for collecting, preparing and transporting specimens for the museum and the information required for each object.[40] In 1792 the Academy receives the natural history collection of the priest José Mayne. However, the museum is only formally constituted in 1834, delayed by foreign invasions and civil war in the first decades of the nineteenth century.[41] It lasts only two decades and in 1858 is terminated and its collections transferred to the Polytechnic School.[42]

THE TWIN IMPACTS OF THE THEORY OF EVOLUTION AND COLONIALISM

Natural sciences underwent significant transformations in the nineteenth century. Generalist natural history gives way to disciplinary (botany, zoology, geology, mineralogy) and sub-disciplinary (mammalogy, herpetology, ornithology, malacology) specialisation. The concept of life becomes central to biology, a new discipline concerned with the internal morphology of living beings.[43] Darwin's theory of evolution is perhaps the most noteworthy development of this period, but, advances in cellular biology by Schleiden, Schwan and Virchow, and the creation of the term ecology to label the study of environmental conditions are also relevant.[44] In geology, Cuvier's stratigraphy, the glaciation theory of Charpentier and Agassiz and Lyell's Principles of Geology also bring major changes in the way geological time and dynamics are perceived.[45] Geology itself becomes increasingly professional, with its own specialized publications and state institutions (such as the Geological Survey in the UK).

These transformations had profound impact on natural history museums. Museum exhibitions were changed to reflect evolution theories, by ordering specimens by chronological series and evolution schemes, from inanimate materials to more complex living organisms:[46] 'the visitor's pathway through most museums came to be governed by the irreversible succession of evolutionary series. If the essential methodological innovations in nineteenth century geology, biology and anthropology consisted in their temporalisation of spatial differences, the museum's accomplishment was to convert this temporalisation into a spatial arrangement. (…) The museum as "backteller" was characterized by its capacity to bring together, within the same space, a number of different times and to arrange them in the form of a path whose direction might be traversed in the course of an afternoon. The museum visit thus functioned and was experienced as a form of organized walking through evolutionary time'.[47] Such is the case of the palaeontology and compared anatomy gallery of the Muséum National d'Histoire Naturelle, 'one of the first exhibitions structured by a narrative plot (…) that popularizes biological evolution'.[48]

Later on, in the early 20th century, research on ecology and the improvement in taxidermy techniques leads to a new approach to museum display, of a contextual nature: the diorama. This consists of a reconstitution of ecological environments though the use of preserved specimens in dramatic postures, integrated in detail rich scenarios, symbolizing reproduction, behaviour or feeding patterns, 'a figurative imitation of nature through abstract

theoretical interpretations'.[49] This kind of display required intensive research and fieldwork and became predominant in European and North American museums.[50]

These transformations reflect not only the close proximity between science and museums, but also a growing concern with the dissemination role of museums, namely with the importance of conveying scientific information to the public via the museum. This is also manifest in the separation between research collections (systematic, comprehensive, all-encompassing) and the exhibition collection (selective, following epistemological and aesthetical options).[51]

Nevertheless, the role museums played in the training of professionals remained central. That explains the creation of new museums within universities, such as Berlin (1810).[52]

Besides this educational aim, in this period natural history museums also take part in the political construction of Nation States. By promoting the systematic collection and exhibition of natural specimens in the geographical area corresponding to the country, they reinforce the sense of belonging to an 'imagined community'.[53] Museums also became a tool for colonial domination, geared towards the economic exploration of natural resources in colonies and to the ideological promotion of an idea of empire.[54]

In the early decades of the nineteenth century the Muséum National d'Histoire Naturelle, with such eminent figures as Geoffroy Saint-Hilaire and Georges Cuvier, led the field of natural sciences in France, promoting scientific expeditions and extending its collections. Later the University of Paris gains prominence in research and the Museum increasingly redirects its efforts to science dissemination, by opening to the public its galleries: mineralogy in 1841, zoology in 1889, palaeontology and compared anatomy in 1898. The museum also takes part in colonial policy, by offering courses for travellers and a chair in colonial agronomy.[55]

In London, the natural history collections are removed from the British Museum and placed in purpose-built facilities in South Kensington, inaugurated in 1881. The collections are displayed by taxonomic groups and the museum receives the legacy of Darwin's expeditions.[56]

Specialized museums, namely in the field of geology, are also created throughout Europe. Their main function was to promote research activities, but they were also geared towards the economic use of mining resources. Such is the case of the Museum of Practical Geology that opened in London in 1851.[57]

THE GROWING FIELD OF NATURAL HISTORY MUSEUMS IN NINETEENTH CENTURY PORTUGAL

Under the influence of international trends but also of national events, the nineteenth century is a thriving period for natural sciences and their museums in Portugal.[58] Pre-existing museums continue to grow and new museums are created, but some also decline and are closed down.

The Royal Museum of Ajuda loses a substantial part of its collections due to the French invasions[59]. First some of them are transferred to Brazil, where they become part of the Rio de Janeiro Museum, then other objects are confiscated and sent to France by Geoffroy Saint-Hilaire in 1808. Some of these specimens were recovered by the King Peter V in 1854 and by Barbosa du Bocage in 1859, who would write later that 'G. Saint Hilaire, who was intelligent, learned and animated by a burning zeal for zoology, used those specimens for the benefit of science, by describing them, whereas before they were laying ignored in the cabinets of the Museum of Ajuda, maybe destined, it they had remained there, to disappear, like so many others, eaten by moths'.[60] In 1835 the Museum is closed down and its collections are transferred to the Museum of the Academy of Sciences (officially created in 1834). This museum also receives the mineral collection of the Mining and Metal Intendancy of the Kingdom, as well as private donations from members and friends.[61]

In Coimbra, in 1885, the Museum of Natural History is divided in four sections led by the professors of each class: botany, zoology, mineralogy and geology and anthropology. It remains solely a teaching and research museum, with no public oriented activities. Fieldwork missions in Portugal and in the colonies are conducted to expand its collections.[62]

Several new museums are created throughout the nineteenth century. The Lisbon Polytechnic School is founded in 1837, the first higher education institution in the capital city to teach natural sciences. The statutes foresaw the creation of a natural history cabinet and a botanical garden. For that reason, the following year, the School Council filled a petition for receiving the Royal Museum of Ajuda collections that were allocated to the Academy of Sciences, justifying this petition with 'the need for natural sciences professors to have at their disposal the means to impart theoretical and practical teaching, since that is the only way to achieve its perfectioning and to raise and develop the taste, among masters and disciples, for the study of the said sciences'.[63] The Academy of Sciences lacked the conditions for exhibiting the collections, which 'impaired the progression of natural sciences in Portugal, stressing the need

for their transfer',[64] as well as the funds for purchasing and preserving specimens, 'a waste and loss that that inexcusable neglect caused, not only from an academic point of view but also for industrial progress'.[65] This petition was approved only in 1858.[66] The Museum regulations were published in 1861, under the official designation of National Museum of Lisbon, and although they stated that the primal aim of the collections was to support teaching, it ought to be open to the public 'as soon as it was properly displayed'.[67] The museum was divided in three sections – botany, zoology, mineralogy and geology – and received funding for scientific missions in the country for collecting zoological and botanical specimens. The activities of the museum naturalists focused on increasing, studying and classifying the collections, as well as publishing scientific papers.[68] The director of the zoological section, Barbosa du Bocage, publishes in 1862 'Practical instructions for collecting, preparing and sending zoological products for the Museum of Lisbon', aimed at colonial authorities, physicians and pharmacists, as well as colonists and inhabitants of mainland Portugal, since 'for collecting the natural products of the locality where one resides, for occupying the leisure of living in the countryside with chores that make the hours fly by and raise the intelligence, for studying nature and seeking to understand the great work of Creation by spelling some of the pages if its history, it is not necessary to be a naturalist by profession nor a university or academy diploma bearing sage'.[69]

Despite receiving numerous donations and materials from fieldwork, the zoological section was never able to obtain complete collections of typical series.[70] Even its director had no illusions regarding the limitations of the museum: 'with the organisation allowed by its means, our institution cannot aspire to assume the importance of the great European museums (…) it is our task to endeavour to make it interesting and worthy to be visited by true lovers of science; it is more important to confer it the special features and its own and exclusive character, to recommend and to ennoble it. In order to achieve this, it requires no more than to gather within it the zoological productions of our country and our overseas possessions and to offer them, well-coordinated, to the examination and study of naturalists'.[71]

The Polytechnic Academy of Porto, created in 1837, was also intended to have natural history cabinets and a botanical garden. However, the natural history collections remained small and disorganized until the final decades of the century, when, partly as a result from pressure from a scientific society,[72] they were taken in charge by the professors of each area, who produced catalogues and a scientific display of the specimens.[73] Thus, the mineralogy, stratigraphy and palaeontology collections were organized by Wenceslau de Lima in 1885, the

zoology museum by Augusto Nobre in 1890, and the Anthropology Museum in 1926 by Mendes Correa.

Another nineteenth century natural history museum was created in the Azores in 1880, the Museu Açoreano, by a local school teacher, Carlos Machado. A few years later, ownership of the museum was transferred to the municipal authorities. Besides holding exhibitions, the museum also carried out research on natural history, meteorology and ethnography.[74]

Similar to other countries, a specialized geology museum was also created in Portugal in 1855, under the administration of the governmental body in charge of this field and with a mainly economic role: the management of natural mineralogical resources[75]. The Geological Museum exhibition was displayed in 1859, but a decade later part of its collections were transferred to the National Museum of Lisbon.[76] In 1901, Nery Delgado described the conditions of the exhibition: 'only a small part is displayed in glass cabinets (…) since there never was the furniture nor the personnel to give it the shape of a real museum. What was done as display, was done by the geologists of the Geological Service, sacrificing precious time of their own studies'.[77]

DECLINE AND REVIVAL OF NATURAL HISTORY MUSEUMS

The early twentieth century was marked by a divorce between natural sciences and its museums. The rise of genetics, micro and molecular biology, which became dominant sub-areas in the field, dictated that these sciences no longer needed extensive museum collections. Universities became the predominant location for scientific research and experimentation came to be the core activity in science:[78] 'having occupied a spot near the centre of scientific stage, museums were primarily displaced by laboratories. It was the later that came to define an experimental ideology of command, control and manipulation which consequently left in the shadows the knowledge based on classification that had been produced by studying museum collections'.[79]

The museums became 'scientific mausoleums' and even lost their role in higher education, since new teaching technologies (experimentation, audio-visual devices) gradually replaced the use of collections. Scientific dissemination to the wider public also suffered with the competition from other museum institutions (such as zoos and natural parks, with live specimens instead of taxidermised ones) and other media, such as cinema and television.[80]

However, the second half of the twentieth century brings on a change in natural history museums' fortunes. On the one hand, growing environmental concerns, coupled with the urgency of informing and engaging the public, create a new role for these museums. Environmental protection can be conveyed not only in exhibitions and educational activities, but also in research and conservation programmes run by museums: 'When exhibits are presented in a meaningful context, and with an appropriate message, they can educate visitors about important conservation issues. About 50 per cent of the world's people live in cities, and that proportion will continue to grow. Because urban life is so disconnected from nature, collection-based institutions have the potential to stimulate curiosity about wildlife, offer educational opportunities about nature, and improve the chances of winning support for its preservation'.[81]

Museum exhibitions have thus started to deal with new subjects, such as environment, nature preservation, interdependency between living organisms, the consequences of human intervention over ecosystems, necessary behavioural changes.[82] International bodies reflect also this new orientation. The ICOM held an international conference on museums and environment in 1972 and the Natural History Museums and Collections International Committee adopted in the 90's as its mission statement that 'Natural history museums (….) must effectively fulfil their vital and unique role in the study of biodiversity, global change, conservation and environmental education. Their collections and associated data are recognised as being essential in fulfilling this function'.[83]

On the other hand, natural history museums have also been influenced by the public understanding of science trend that developed from the 80's onwards. The relation between science and the public became a cause for concern for scientists and policy-makers, since supposedly low levels of scientific literacy, of enrolment in science-based secondary and upper education courses, and of public trust in science were diagnosed as a social problem requiring the public's attention, scientific analysis and political intervention.[84] The 'public understanding of science' movement consisted of an array of initiatives that 'amount almost to a public understanding of science industry, which is colonising small corners of academia, commerce and politics and generating its own momentum', producing 'clearer perspectives on previously ill-defined or even undetected problems; policies and activities designed to deal with these problems; and manifestos and protocols designed to redesign professional and educational practices'.[85] In addition to the economical (to train a sufficient number of both scientists and engineers, but also industrial workers) and the professional (to generate support for scientists) motivations, the dissemination of scientific knowledge among the population was justified also

by the need to empower citizens: 'democratic citizenship in a modern society depends, among other things, on the ability of citizens to comprehend, criticise and use scientific ideas and claims'.[86] In contemporary societies, it is assumed that the public needs to possess some scientific information in order to function efficiently both in daily life (to deal with all the technological devices that surround them, to make informed consumer choices) and in political participation forums (to elect their representatives, to take part in public consultations in matters of risk, environmental assessment, consensus conferences, etc.).[87]

It became widely expected that natural history museums would play a role in improving 'scientific and ecological literacy': 'Some of today's hottest political topics are deeply influenced by science, for instance, energy production, acid rain, biodiversity, gene technology and therapy, AIDS and legislation. Consequently both politicians and the electorate should have a working knowledge of science, not to become experts, but to be adequately informed, to be able to discriminate between fact and fiction and between a well-founded argument and mumbo-jumbo. In a democratic society citizens should be able to analyse and see through expert reports and political arguments veiled behind a varnish of science'.[88]

As a consequence, these issues became subjects for exhibitions and other museum activities. Natural history exhibitions also changed their display patterns, mimicking the practices of science centres, through the inclusion of interactive, hands-on devices, robotic models (often of dinosaurs), audio-visual displays and games, reconstitution of natural habitats through which visitors can walk, spaces with living animals (aquariums, terrariums, beehives, cages with birds), discovery rooms where visitors can manipulate specimens, see samples on a microscope or perform basic experiments.[89] Museums have also striven to function as meeting points between scientists and the public, conveying information between the two sides, which has been manifest in exhibitions that include references to the scientific work underlying the displays, in laboratories viewable by the public, in guided tours behind the scenes or in field expeditions.[90]

This is also connected to the educational function of museums. Although their role in higher education remains limited, much investment has been made in non-formal education, both of adults and school children. Educational services have become increasingly important, promoting a wide range of activities, participating in the design of exhibitions, developing pedagogical materials, taking part in teacher training, carrying out research on pedagogy and learning through the museum medium.[91] Again, the mission statement of NATHIST postulates that 'Natural history museums must vigorously promote educational programmes

and exhibition themes of high quality (…) to create greater public awareness of environmental issues both in the life and earth sciences'.[92]

Finally, the research function of museums has been partially bolstered, both by investing in areas that have been neglected by university departments (such as palaeontology, botany, zoology, entomology) in order to carry out preparatory work for exhibitions but also fieldwork and specimen collection,[93] and by discovering a new scientific role as 'observatories of nature and memory or its evolution'.[94] Collections function as archives, they 'document biodiversity and its distribution and to serve as a resource for research and education (…) each specimen is unique, providing multidimensional documentation in geographic space (locality), biodiversity space (taxonomy), and position in time (date)'.[95] Museum collections are one of the few places where specimens from extinct species can be found and samples can be used in new areas of biological and environmental research: the presence of environmental contaminants over time, the genetic diversity of populations, the workings of food chains, responses to climate change, population decline in certain species, biodiversity drop.[96]

Again, these general trends can be illustrated by the cases of the two main natural history museums in Europe. After some decades of relative winding down of activities, the director of the Museum Nacional d'Histoire Naturelle during the 50's, Heim writes an article in the UNESCO magazine, Museum International, proposing as a solution for this type of museums, namely a closer connection to more dynamic scientific domains such as ecology, biogeography, genetics and ethology, as well as the need to reintroduce nature in museums: to show the results of field studies and to raise awareness among visitors to the necessity of protecting nature. The Museum created in 1955 a chair in ecology and nature protection and in 1962 a service of nature preservation.[97]

However, it is only in the eighties that major overhaul works begin in the zoological exhibition. In 1994 the Great Gallery of Evolution opens to the public, with a permanent exhibition dedicated to three main subjects (the diversity of living things, the evolution of life and man as a factor of evolution), coupled with a 'discovery room' with interactive devices and games.[98] The aim was to transform a centuries old museum into 'a true centre of scientific culture, a showcase for illustrating the concepts raised by a science on the making. The ambition was great, because we wanted to show visitors, through the concept of evolution, how scientists, through uncertainties, questionings, hypotheses that are verified or not, had built and modelled the theory of evolution throughout the past two centuries. And to make them understand that science does not provide definite answers but rather offers explanations that give rise to new

questions'.[99] The Museum continues to carry out research, some its centres are affiliated to CNRS, and it evens grants doctoral degrees since 1989.[100]

The Natural History Museum of London began its transformation process in the seventies. Gradually, systematic and taxonomic exhibitions have been replaced by thematic exhibitions, dealing with ecology, human biology, evolution and the origin of species, cosmology, volcanology, earthquakes, and climate change. Most of these displays have interactive and multimedia devices. In the beginning of the twenty-first century, an ambitious project named Darwin Centre opened to the public: the museum reserves and laboratories became accessible to visitors via information screens, guided tours, daily lectures and demonstrations and video-conferences with researchers both inside and outside of the museum.[101]

PROXIMITIES AND DISTANCES BETWEEN PORTUGUESE MUSEUMS AND CONTEMPORARY TRENDS

The reform of higher education in 1911 had implications over the natural history museums of Lisboa, Porto and Coimbra. All three became annex institutions to the Universities but the division into separate sections was kept. Teaching duties remained paramount, but a 1919 decree clarified that the National Museum of Natural History should retain its autonomy, since 'there should be conducted studies not only of taxonomy, but also experiments and research in all fields of the nature sciences, both basic and applied – to study, to guide and to exemplify, so to say, the direction of scientific research at its use. Such an end is completely different of the teaching function of courses, it can be its complement, but not its main element, to avoid the risk of neither the courses nor the National Museum accomplishing the objectives they should aim to'.[102]

Throughout most of the century, these museums remained closed to the public and solely devoted to teaching and research: 'by using its laboratories, its technicians and auxiliaries, here the highest level of teaching in the three branches of the natural sciences was carried out and laboratory support to research was provided, often connected to PhD thesis and to publication in the museum's scientific journals'.[103] Scientific missions to the colonies were carried out and collections were added. The museum sections created their own scientific journals and took part in the foundation of the Portuguese Natural Sciences Society (1907) and

the Portuguese Biological Society (1922).[104] However, changes in the dominant paradigms of the natural sciences progressively decreased the relevance of working with museum specimens.

The geological section of the National Museum of Natural History did manage to open one of its galleries to the public once a week, between 1934 and 1972, but the display was geared towards the needs of lecturers, students and researchers: 'the static nature and sheer volume of the collections that were displayed, as well as its overlong permanence, without any renewal for extended periods of time, made it unable to attract any other audiences besides the academic ones. Nothing in the analysis of its recent history leads us to believe that this museum was ever intended for disseminating geological culture among the wider public'.[105]

A similar state of affairs was experienced at the zoological section: 'the museum has its collections pilled inside ugly one kilometre long cupboards along its two thousand square metre rooms, without any glass cabinets, with the specimens all lined up inside old containers or on polished pedestals. As a scientific museum it is a huge deposit (…) of precious scientific material (…) as a public museum it satisfies none of the modern museological demands and as such it has remained closed'.[106] The director of the museum between 1925 and 1957, Artur Ricardo Jorge, defended the need for the museum to play both a scientific and a public dissemination function, this latter justified by the need to encourage vocations in natural sciences, and made a request to the Government to initiate the construction of the new building for the Faculty of Sciences that would include specialised facilities for the National Museum of Natural History, in order of it to be 'at the same time a moment and indicator of the cultural degree, the imperial width and the spiritual greatness of the Portuguese People'.[107] Under his direction, the museum was modernised, the research and exhibition collections were separated, a new didactic collection was formed and the exhibition, displayed in taxonomic order, was open to the public in 1952, although only infrequently due to the lack of staff.[108] However, the following director disagreed with most of these options and considered that it no longer made sense to aggregate three diverse disciplines under the obsolete name of natural history and that there were no conditions in the museum to open a modern exhibition and that the research function had been unduly neglected.[109]

The seventies are characterised by substantial transformations in the strategy of the museum, if not its actual activities. The Faculty of Sciences is transferred to new buildings in the university campus and the museum departments are left behind in the Polytechnic School, which signifies a spatial divorce between the museum and teaching and research that had already been happening in practice.[110] The geological section shows a new 'awareness of the

educational and cultural roles of the museum'.[111] It undergoes an internal reorganisation, new laboratories and archives are built, and a temporary exhibition is planned, 'scientifically up to date and following the rules of the new museology (…) showing the materials in an attractive way, connecting them with geological phenomena, offering a simple, clear and accessible reading, of a high scientific level'.[112] A museological plan is designed and sent to the Ministry of Education, together with a request for funding.[113] The zoological section is in a worse state of disrepair but plans are also drawn to restructure it and 'make it suitable for fulfilling the functions for which it was created, with regard to popular education and culture'.[114] It also dates from this period a proposal to develop the whole National Museum of Natural History, 'as a means to disseminate culture, to develop and publicise scientific knowledge, to provide populations with an pleasant way of improving their knowledge of their own country, to offer young natural science students a way of grounding and developing the bookish teachings they received'.[115]

However, all these intentions suffer a major setback with the catastrophic fire that severely damaged the Polytechnic School in 1978, destroying much of the museum collections (especially the zoological ones). Over the next three decades, the museum embarks on a slow and painstaking process of renewal, now almost completely geared towards a public role. Although research activities are still pursued (the museum still has researchers in its staff and publishes scientific journals)[116] much of the resources are channelled to exhibitions and events for school children and the general public.

This renovation was carried out more swiftly in the geological section, which in the eighties created an educational service and started promoting temporary exhibitions, holding lectures (in a makeshift auditorium made of scaffolding), publishing a newsletter: 'The museum didn't want to die and we started with a very small exhibition in the basement, with only one glass cabinet (…). Dinosaurs was an appealing subject, that brought children into the museum to see what little we had, so we organised pedagogical workshops to have students come over. Since we didn't have a museum in the traditional sense, an open doors museum, open to tourists, open to the population, we had huge gutted salons, we had to have some activity, conferences debates, symposiums'.[117] The key turnaround moment is the astonishingly popular 1993 exhibition on dinosaurs, with robotic models rented from the Natural History Museum in London, which set the standard for a regular programme of exhibitions that were held in the following decade and a half. Educational and public understanding of science concerns have become paramount in the content and form of these exhibitions: see for instance the latest

exhibition, 'Allosaurus, a dinosaur, two continents', which is the result of a research project and aims to show the scientific process underlying new knowledge on a particular species, drawing on not just preserved or replica skeletons, but also on reconstructions of diggings and pieces that can be touched by the visitors.

Conversely, during this period the zoological section invests mainly on research and on recovering its national collection through new scientific missions. The then director opted out of holding exhibitions in 'unplastered rooms' and a permanent exhibition on ecosystems only opened in the nineties due to the inflow of funding from European programmes (CIENCIA). This orientation changed in the first decade of the 21st century, when a new board of directors began promoting temporary exhibitions and opened a new permanent exhibition about nineteenth century zoological cabinets. A new team of young researchers is also behind some very innovative exhibitions on butterflies (2006)[118] and insects (2010). This may signal a shift towards environmental issues, in tune with the trend in major European museums.

Although formally under a common structure, successively reaffirmed in statutes and regulations, the National Museum of Natural History functioned for most of its history as three separate departments, with separate staff, governing bodies and activities. This has changed slightly in the last few years, with the organisation of joint exhibitions and events. The latest version of the statutes (2003) places the museum under the direct responsibility of the Rectorate and assigns it the mission of 'the development of museology based on the scientific and cultural collection accrued and the results of scientific research that is carried out'.[119]

In Coimbra, it is also noticeable a change in direction of the university natural history museum towards a more significant public role. The publication of new museum statutes in 1996 signals a renewed interest by university authorities, as well as a redefinition of aims: 'The Museum of Natural History is a scientific museum, in which research and dissemination of scientific knowledge ought to be primordial in the dynamics of its activity. (…) The specific aims of the museum are: a) To promote and develop scientific and cultural actions within the sciences related to the four sections; b) To promote and carry out basic research and experimental development (…); c) To preserve its collections; d) To enlarge its collections (…); e) To publish the results of its activity…'.[120] However, each section retained a high degree of autonomy and all except the anthropological section opened to the public permanent exhibitions, with fairly modern museological concepts: Mineralogy and Geology in 1995, Botany in 1998, Zoology in 2000 and 2004. However, a project for gathering together all the university collections in a single Museum of the Sciences was unveiled in 2004, which faced

some resistance, since it meant to dismantle the hard-won exhibitions. A first common exhibition, with objects from all the sections was inaugurated in 2006, on the theme of light and matter, and work is under way to transform the main building of the museum.

In Porto, a much similar process occurred. New legislation was published in the nineties, also with the aim to revitalise the Natural History Museum, and gradually all the sections renovated their exhibitions, although they have been infrequently open to the public. Some fairly successful temporary exhibitions have been held and there is also an ambitious plan to gather together all the university collections in the historical building of the Rectorate, but so far this has failed to materialise.

Accompanying the constitution of new universities and polytechnics, a few new natural history museums opened in the final decades of the twentieth century. Such is the case of the geological museum of the University of Tras-os-Montes e Alto Douro (1985) and the Botanic Museum of the Polytechic of Beja (2002). They combine both scientific functions (to support research and training) and public dissemination functions.

As to the Geological Museum, if followed the fluctuating fortunes of the Geological Services. After a period of neglect in the first decades of the century, from the forties on its activities were revitalised, benefiting from an inflow of funding, the work of renowned researchers (such as Georges Zbyszewski, Henri Breuil, Orlando Ribeiro, Carrington da Costa, O. da Veiga Ferreira, Afonso do Paço and Abel Viana) and ambitious tasks such as the systematic cartography of the country (with greatly expanded the collections). Although the museum retained a primarily scientific role, some activities with schools were carried out.[121]

Nevertheless, in the seventies the museum remained a scientific deposit of specimens, even though the archaeology room was given a more visitor friendly makeover and there were plans to extend this renovation to the other rooms: 'we are the first to acknowledge that this museum could and should be more attractive and educational to the public. Although such a transformation is expensive, we are doing our best efforts to achieve this aim'.[122] A new effort of modernization was done in the nineties, triggered by the awareness of the dwindling role of support to research. Part of the exhibition was renovated, temporary exhibitions and other activities were organized, and a newsletter was published. Some rooms were preserved in their original forms, as "museums of the museum'[123]. The museum objectives were defined as such: '1. To collect, preserve, study and publicise the evidences of the Portuguese geological, mining and archaeological heritage; 2. To provide support to the research works of the Geological Institute and the national and international scientific community, by improving access to the

reference collections; 3. To promote dissemination and cultural activities, in an open and multicultural perspective; 4. To sponsor and support the study, preservation and safeguard of the Portuguese geological, mining and archaeological heritage'.[124] But a lack of human and material resources, as well as institutional upheaval (the Geological Institute to which the museum belongs was successively extinguished and reinstated) put much of these endeavours on hold.

In Ponta Delgada, Azores, the natural history section of the municipal museum gradually lost relevance to the artistic and ethnographic collections. But in 1933 a new museum of natural history is created in Funchal, based on zoological and botanical collections gathered by several priests, that to this day retains its scientific nature.

The final tier of the twentieth century is marked also by the opening of local museums devoted to natural history, attached to municipal authorities or associations. Such is the case of the Museum of the Sea in Cascais (1976), the Luís Saldanha Oceanography and Fishing Museum (1978), the Lourinhã Museum (1984), the Natural History Museum of Sintra (2009), as well as of several museums in project (Batalha, Viseu). This is part of a wider trend of growth in local museums but is also shows a renewed interest in natural sciences and a new way of conceiving local heritage, no longer confined to archaeology and ethnography. Many of these museums even develop research activities, such as paleontological diggings, although their main aim is to promote local identity and tourism, by carrying out exhibitions and events aimed at the general public.

CONCLUSION

Throughout their two and a half centuries old history, natural history museums have changed. Missions, activities and display practices have been transformed in response to the mutations of the natural sciences but also of societal challenges. The rise and fall of theoretical paradigms and changes in empirical methods dictated the fluctuating relevance of museum collections. The development of higher education and the training needs of natural sciences practitioners have also mutated over time, first promoting, then demoting the use of museums. Changing social conceptions of nature, from a resource to be exploited to an endangered good to be protected, transmuted also the role of museums. National, colonial or local ideologies have likewise been served by museums at different stages. Under different guises, the effort to bring science to the public has always been one of the purposes of these institutions. The functions of

natural history museums and the three main audiences they serve – researchers, students and the public – have remained constant. It is their relative importance that has varied over time.

These trends are noticeable on general terms all over the western world and Portugal is no exception. Even though influenced by particular national events and with the usual time delay (and financial constraints) from tendencies in the core countries, Portuguese natural history museums lived through most of the expected stages and evolved in line with their social and scientific environment. Although this article has left out a few other museum types that played significant roles in the relationships between the natural sciences and their publics, such as botanical gardens, zoos or aquariums, it has striven to illustrate the shifting purposes that steer museums' activities and displays.

Museums have changed and evolved, but an acknowledgement of their history has always been present in these transformations. Although modern and interactive exhibitions abound, most of these centuries-old museums, both in Portugal and abroad, take pains to preserve and show visitors a glimpse of past collection and exhibition practices, usually through recreations of natural history cabinets. And when what is at stake is deciding on the future of these museums, such as the 2010's public consultation on the National Museum of Natural History, promoted by the Rector of the University of Lisbon, a historical and comparative perspective is indispensable to make informed judgments.

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Scientific Institutions as Sites for Dissemination and Contestation: Snippets from Colonial India

By Deepak Kumar*

Scientific institutions are modern icons. They arrived in India as part of the colonial baggage and soon became the carriers of new ideas, and in fact they came to symbolize modernity itself. Was this a smooth process? What debates did institutionalization spark? The quest for knowledge has never been alien to Indian society and there were knowledge institutions also in pre-colonial times. What changes came in the nineteenth century? Can they be explained in terms of metropolis-periphery relationship or impact/response studies? Did the process of institutionalization differ in colonial and non-colonial settings? The same questions could be made for the process of professionalization. How to 'straddle the spatial and epistemological divide' between metropolis and colony? [1] Was this a one-way transfer? And one can also add, was this a derivative form of knowledge? Could it produce autodidacts or intellectual-migrants who could hold on their own? Is indigenous knowledge 'original and unsullied' to be taken in opposition to modern/scientific knowledge? Could they interact; could they change? Was a synthesis or co-production possible? The present paper attempts to address these questions with the help of examples and illustrations from a colonial city, Calcutta.

Much before South Asia was properly colonized, numerous travelers and traders had delved into the characteristics and peculiarities of other peoples and societies. India was no tabula rasa. But as conquest began, new forts, ports, and cities were established. Thus came into being the new port cities of Calcutta, Bombay, Madras. These were to witness a distinct break with the past. In the new cities new institutions were established in contrast to the older cities of Delhi, Hyderabad or Lahore. Some of these institutions were to become the carriers of new knowledge. It is not easy to see them as sites for knowledge exchange as this would involve a two-way process which colonial conditions would seldom permit. They mostly functioned as sites for dissemination and also contestation. Nevertheless, the transfer of knowledge, though purported to be osmotic, was not really a one-way simple process; it sparked debates and produced cross–currents. This can be seen in full–flow in the history of Calcutta.

The emergence of Calcutta as a science city is synonymous with its growth as an imperial city or perhaps even with imperialism itself. Here, one may ask, can there be an imperialist side to natural knowledge? Many would argue that science is universal; and certainly one cannot call it colonial simply because of its association with colonial cities! Many authors believe socio-political circumstances do shape natural knowledge. More so in a colonial framework. The essence of colonialism is dependency, so is that of colonial science. The colonial scientists were offshoots of the metropolitan culture and drew sustenance from it. Roy MacLeod defines metropolitan science as not just the science of Edinburgh of London, Paris or Berlin; but as a way of doing science, based on learned societies, small group of cultivators, certain conventions and certain priorities. [2] The colonial scientists were also a small group of cultivators; they also established learned societies; but the priorities, realm and scope of investigations were not always determined by them. This made all the difference. It became mostly derivative, and was, in the eyes of the metropolis, some sort of a dependent, if not low science, identified usually with data gathering.

There is one more dimension. Natural knowledge serves to confer prestige on the metropolitan power and thereby legitimize imperial control over peripheral territory. But prestige alone could not have been the sheet anchor for the empire. So, the focus was directed towards the applied sciences- botany, meteorology, physiology, applied mechanics, etc. I am not arguing that all science at the periphery was applied science. An obvious counterexample would be astronomical observations. But colonial science was primarily science applied to production of systematic knowledge about the colony (its flora, fauna, minerals and topography) and the solution of certain practical problems of the day. Certain material benefits did accrue and some 'development' did take place. But here the key question, which has been the subject of several long debates, arises: whose development and for whom?

One thing is clear, colonial science does represent an advance over pre-colonial science. For example, pre-colonial India did not have any scientific society or any scientific journal. As a result, research remained esoteric and tended to get lost. Mostly it took the form of commentaries which continued with the older traditions albeit minor changes. An excellent example is Sawai Jai Singh (1688-1743) who tried to assimilate and synthesize the astronomical knowledge then available to him but who could not transcend the barriers of canonical (siddhantic) knowledge. [3] He had attracted several scholars to his court but he never thought of establishing an institution that would continue and improve on his work. It was a curious situation. On the one hand, one finds Mushibullah al-Bihari writing Risalab Juz 'la Yatajazza,

an Arabic treatise on the indivisible atom, and two other texts on motion and time (1700); on the other hand is Walih Musawi (1700-1770) writing Murgh-namah (on cock fighting) and Kabutar-namah (on pigeons). [4]

As the British strengthened their grip by the end of the eighteenth century, and as interaction with the West grew, Indians did try to look out and look within. For example, in 1790 Mir Hussain Isfahani wrote Risalah-i-Hai'at-i-Angrezi, a Persian text on European astronomy. [5] Many commentaries were written during this period; although they did not entail a paradigmatic change, neither were they slavish. In fact, composing commentaries was considered a civilized form of making progress. [6] In several instances (especially in medicine) these commentaries explain scientific knowledge in terms of its own rationality and logic, but in the final analysis when the validity of certain knowledge was put to test, the sacred texts were always the standard measure. At the peak of Mughal glory, Abul Fazl had mourned "the blowing of the heavy wind of taqlid (tradition) and the dimming of the lamp of wisdom… The door of "how" and "why" has been closed; and questioning and enquiry have been deemed fruitless and tantamount to paganism". [7]

Against this background of intellectual torpor and the colonial onset, William Jones founded the Asiatic Society in 1784. This society soon became the focal point of all scientific activities in India. This was a unique experiment, probably the first such in Asia. The scope and objects of it enquiries were: 'Man and Nature; whatever is performed by the one, or produced by the other.' [8] What could be colonial in such magnificent objectives?! Nothing. The difference lay in practice. Though the criteria for its membership was nothing more than 'a love of knowledge and zeal for promotion of it', Indians were not taken as members until 1829, and no Indian made any scientific contribution to its journal till the 1880s.

The roots of professional and scientific colonial literature from the viewpoint of science can be traced back from the publication of the Asiatic Miscellany (1785). It soon flowered into Asiatick Researches (1788-1839) and the Journal of the Asiatic Society(JAS). Between 1784 and 1839, the Asiatic Society published 20 volumes. The demand for the publication was such that in 1798 a pirated edition was brought out in England. It is impossible to look at the JAS without considering the role played by Orientalism in its development. Orientalism led to the study of Eastern civilizations by scholarly Europeans. The literary researches of the `Orientalist' scholars complemented scientific investigations in colonial India. Orientalism had its most visible manifestation in the nineteenth century and is symbolized in India by the development of the Asiatic Society. It had its supporters and detractors. On the one hand, it can

be said that it rediscovered the history and culture of the subject people and cast it in a modern idiom and promoted global awareness of diverse civilizations. On the other hand, going by the critiques of Edward Said, orientalism was the vehicle by which Western civilization penetrated into the civilizational hearts of its subject and function as an inseparable handmade of imperialism. Both the defence and critiques of Orientalism would also apply to the mindset and the body of thought and action that gave rise to these journals. [9] There is equally an element of self interest as well as reform in their study of natural resources, topography, socio-cultural traits, diseases, etc. in the native milieu.

The Asiatic Society suffered and prospered simultaneously but remained a beacon of knowledge for long. It was the sole organ of research in Asia. Whatever was done in geology, meteorology, zoology and botany was done through the Society. Gradually all these branches developed lines of their own and blossomed into separate departments. The society multiplied by fission, like the 'philoprogenitive sponge' and gave birth at successive epochs to the Geological Survey, the Indian Museum, the Meteorological Dept., the Botanic Survey, and the Linguistic Survey. [10] As Nature noted in 1907,

Like all the scientific organizations in the East, it has suffered vicissitudes. The short and broken residences of Europeans in the country, pressure of official work, lack of native co-workers, want of libraries of reference, and last, not least, the indifference of the Indian Government, which prefers that its servants should devote their spare time to the judgements of the High Courts or the circulars of the Board of Revenue rather than to the science and literature of the country, have at times interrupted its progress. [11]

Another important scientific society was the Calcutta Medical and Physical Society, established in March 1823. The objectives of this Society were twofold—first to collect original papers relating to discoveries in medicine and surgery, and in the branches connected with them, as researches in anatomy, physiology, botany, chemistry for the advancement of professional knowledge, for the mutual benefit of the members, more particularly with reference to Indian diseases, and treatment—the papers would be presented, read and discussed at regular appointed meetings and afterwards published, and entitled Transactions of the Society. And the second objective was the formation of a select and extensive medical library for the use of its members. It broke the social and professional isolation of the doctors, and without any government aid, was able to publish its Monthly Circular and Selections regularly[12] . The Medical and Physical Society of Calcutta elected four Indians – Radhakant Deb, Ramcomul

Sen Madhusudan Gupta and Raja Kalikrishna Bahadur, as corresponding members in 1827 and they did produce few papers on indigenous drugs. [13]

These societies rendered invaluable services, particularly through their journals whose standards compared very favorably with that of European ones. It was no minor achievement that Calcutta, with a public of a little more than two thousand people, could produce and support scientific journals like the Gleanings in Science and Calcutta Journal of Natural History. The latter even attempted to establish in 1841 an Indian Association for the Advancement of Natural Science [14] based on the pattern of the British Association for the Advancement of Science.

These voluntary societies were important institutions in their own right. I shall not cover the official institutions like the Royal Botanic Garden, the Calcutta Mint, the Geological Survey, the Telegraph Department, etc. because these institutions worked along government lines and had little public contact. The voluntary societies definitely had more stimulating effect on the city life. But their works could have reached the mass of local people only through educational institutions to which we now turn.

Educational Experiments

One of the intentions mentioned in sec. 43 of the Charter of 1813 for the grant of one lakh rupees to be spent in education was the introduction and promotion of scientific knowledge among the inhabitants of British India. [15] But the Court of Directors gave no directive as to which system of science, indigenous or European, was to be preferred. The Court perhaps tried to avoid taking sides and took refuge in the neutrality of the engraftment principle, calling for the fusion of the scientific and medical techniques of both East and West. The result was that the whole issue got bogged down into what became known as the Anglicist-Orientalist controversy [16] which the former finally won. Macaulay's distaste for science, the mechanical arts, astronomy, and engineering, led to a curriculum which was purely literary. [17] The entry of science was thus delayed. In July 1835 the General Committee of Public Instruction recommended even the abolition of chemistry instruction. [18] An influential contemporary journal wrote: "More useful knowledge is to be gained from the study of one page of Bacon's prose, or of Shakespeare's poetry than from a hundred pages of Euclid." [19] Against this backdrop began the Victorian era.

Purely scientific education did not fit into the exigencies of the Company Raj. But the need was felt to have a class of apothecaries, hospital assistants, surveyors, and mechanics to serve the fast-growing medical, survey and public works departments. Training native youths was obviously much cheaper than getting technical personnel from abroad. So it was opened in 1935 the Calcutta Medical College [20] and in 1843 an engineering class started at the Hindu College. [21] In 1844 was revived the idea of having a Chair of Natural and Experimental Philosophy. But the controversy arose whether the emphasis was to be put on pure science or on applied science. [22] Around the same time Dr. F. J. Mouat, Secretary of the Council of education, floated the idea of establishing a university. [23] But it was only to be a mere examination body and thereby could not have produced a boost to science education as such.

The university system could not dispel the air of pessimism which hung round science education. Rather, it got accentuated in the name of liberal education. Physical sciences were removed from the list of necessary (viz, Languages, History, Mathematics and Mental & Moral Science) subjects for B. A. Examination. [24] W. S. Atkinson, the DPI of Bengal, wrote: 'Indeed if I am asked what steps should be taken by this Department in furtherance of original research, my answer must be none': and then added the same old ecclesiastical cliché, 'the causes which have produced the degradation of centuries of moral, social and political debasement'. [25]

The question was not that natives were not receptive enough. That the students reciprocated well can be asserted in what J. Prinsep wrote to O'Shaughnessy after examining the chemistry students of the Calcutta Medical College: 'All the essays are extremely creditable; indeed the extent and accuracy of the information has far surpassed my expectation and I do not think that in Europe any class of chemical pupils would be found capable of passing a better examination.' [26]

Vernacular periodicals like Samvad Prabhakar, Tattvabodhini Patrika, Somprakash etc. every now and then harped upon the importance of science education and research. Somprakash, for instance, observed that 'in a country like France even at the primary level or at the very ordinary school sufficient attention is given to science. In India the study of true science is negligible. It remains limited to the Roorkee Engineering or Medical Colleges. In 1869 the Asiatic Society proposed that science should be studied properly at the university level right from the Entrance. But the Govt. refused by saying that the time was not yet ripe. Is not the Education Department the cause of our scientific and technological backwardness?' [27]

Although the Calcutta University was avowedly founded on the model of the London University, the Oxbridge tradition was apparent in the exclusion of science. [28] The education system led to the acquisition of literary, rather than of scientific tastes---- 'tastes which are best satisfied by the profession of the lawyer, teacher, or the government official.' [29] Bombay was the only University to confer a separate degree in science. The scientific course in Bombay, Lahore and Calcutta were almost similar, except that English, which formed a compulsory subject at Calcutta, was altogether excluded from the two former, and that Mathematics, optional in Bombay, was a compulsory subject at Calcutta and Lahore. [30] Quantitatively, the science course was less popular but it produced better results and was preferred by scholarship holders. In 1882 the DPI of Bengal reported that the percentage of success was 20 in literature course and 46 in the science course. [31] The science course continued to grow in popularity and in 1899 the Calcutta University decided to institute the degrees of B. Sc. and M.Sc. [32]

From Dependence to Independence

One of the first men to realize the necessity of re-articulating science in national terms was Mahendra Lal Sircar (1833-1904). In 1869 he wrote an article 'On the desirability of a national Institution for the cultivation of sciences by the natives of India'. This title is extremely significant. He argued against the prevailing contention that the Hindu mind was metaphysical, and called for the cultivation of the sciences by 'original' research. He wrote, 'we want an Institution which will combine the character, the scope and objects of the Royal Institution of London and of the British Association for the Advancement of Science'. And then he added, 'I want freedom for this Institution. I want it to be entirely under our own management and control. I want it to be solely native and purely national'. [33] In Apri11875, Bharatvarshiya Vigyan Sabha (an all-India Science Society) was formed. Its objects were: (1) to discuss science as a subject by instituting a Society at Calcutta, which would have branches in other parts of India; and (2) to educate the people of India in various scientific subjects and to publish all the ancient Indian tracts relating to science. [34] In 1876, after a great deal of effort and controversy, the Indian Association for Cultivation of Science was inaugurated in Calcutta. This event was no less important than the establishment, nine years later, of the Indian National Congress, a political forum that was to spearhead the national movement. The Association was a cultural challenge and symbolized the determination of a hurt psyche to assert and stand on its own in an area that formed the kernel of Western superiority.

The turn of the twentieth century saw intense debates on what the Indians had received at the end of a century and a half of British rule. A cursory look at the periodicals, pamphlets and publications of the time would show the high level of discontent with the situation. [35] Even the then Governor General agreed that a huge stratum of the society retained 'the primordial elements far away from the reach of progress.' [36] In the first decade of the twentieth century amelioration was sought through the slogans of Swadeshi (self-reliance) and Swaraj (self-rule). These were more than political slogans; they symbolized rather an intense yearning for change. [37] The 'new vision' of India that came to be debated so intensely in the years to follow, had its beginnings in the last two decades of the nineteenth century. The quest for 'techno-scientific knowledge' preceded and facilitated the emergence of such 'vision'.

Calcutta's Scientific Pioneers

A large number of Indian interlocutors, belonging to different disciplines and walks of life, contributed to the new quest for techno-scientific knowledge. Among those who were the first to take scientific research and teaching as their career were Pramathanath Bose (1855-1934), Ramendra Sundar Trivedi (1864-1919), Jagadish Chandra Bose (1858-1937), and Prafulla Chandra Ray (1861-1944).

P.N. Bose specialized in geology at the University of London and later joined the Geological Survey of India. In 1886 he wrote a pamphlet on 'Technical and Scientific Education in Bengal' and a decade later he published the three volumes of 'A History of Hindu Civilization'. Fierce nationalism transformed a geologist into a historian. From physical mapping he shifted to cultural contours. He held the Brahmanical system responsible for neglecting physical science 'to a most serious extent'. 'The Hindu civilization carried the germs of its decay within it', he argued. But he would never agree to his (geological) Chiefs perception of Indians as 'utterly incapable of any original work in natural science'. [38] He could see no reason why 'with an improved system of scientific education, and with just and sympathetic treatment of the young men trained in India, they will not be able to take a place in the modern scientific world.' The Japanese 'instead of being thwarted, discouraged, and set down as incapable, have been aided, encouraged and stimulated by their government to pursue science.' [39] Bose only forgot to mention that Japan was not a colony! But he did realize (at his own cost) that 'a just and sympathetic treatment' was not always possible in a colony. Every concession had to be literally wrung. It was a struggle in slow-motion but on a high pitch. In 1886 P.N.

Bose asked for a science course at the F.A. (intermediate) level to facilitate early specialization. It was not till 1906 that an intermediate science course was introduced. He also pointed out the defects in the B.Sc course which was itself divided into literary and scientific curriculum. The Presidency College had no chairs in botany, zoology, and geology. Officers of the Geological Survey were asked to teach geology on a purely temporary basis. One could imagine what progress would come from such 'intermittent lectures.' The case was similar to the one at the Bengal Engineering College in Shibpur where chemistry, physics, geology, and metallurgy would be taught by 'one and the same teacher.' [40] Bose wanted science subjects to be taught with an eye to their application to industry. But at the same time he warned against the dark sides of industrialism in Europe which was feeding 'the growing spirit of militarism and imperialism in the West.' [41] He would have preferred the cultivation of science and technology within 'the limits of intellectual culture.' Later the experience of the First World War made him revert to 'the propagation of ancient culture' (as represented by India) which would 'rescue the humanity from the morass of militarism, malevolence, destitution, disease' etc. [42] Thus P. N. Bose wanted change and progress but on his own cultural terms and without losing Indian values.

A sharper articulation of the cultural dimensions of techno-scientific education came from Ramendra Sundar Trivedi, a science teacher at Ripon College (later its principal) in Calcutta. He wrote a number of thematically-rich yet seemingly popular science articles in Bengali which were published in book form under the titles Prakriti (1896) and Jigyasa (1904). Thanks to the English education, one may have learnt a great deal. But 'have we acquired the ability to learn on our own?'

'Have we assimilated scientificity into our system? The very word science throws us into raptures, but what we ultimately imbibe is basically pseudo-science. Having heard that human hair is a non-conductor of electricity we immediately begin growing pigtails; and as soon as we learn that changes in lunar position cause tides we take our horoscopes to the astrologer. Can one think of a more piteous situation?' [43]

This comes from a person with a supposedly Brahmanical and revivalist bias. But such poignant questions would have occurred only to such persons who had a deep understanding of their traditions and who were able to relate the latter to the ideas and requirements of their own time and locale. Trivedi even tried to expand the realm and definition of science.

'Science! Science! We all aspire for scientific research. As if science is confined only to physics, chemistry and physiology. As if anthropology is beyond the scope of science – as if historical analysis is outside science's concern.' [44]

Such a holistic view may not be appreciated by today's scientists, but a century ago that was not the case. In fact, scientists like P.N. Bose and P.C. Ray turned into wonderful historians. Like them, Trivedi could see the distorting influence of the colonial system and its bureaucracy. The educational system had become 'mechanized', with the universities reduced to little more than degree-granting machines. Even private efforts had come to a naught. Trivedi criticised the content and quality of education in the tols and chatuspatis, but he thought that these had at least some 'genuine respect for knowledge'. Modern educational institutions, because they followed 'mechanized routine,' failed to inculcate such genuine respect. They became what P.C. Ray later called 'golam-khanas' (slave-factories), churning out munsifs, clerks, assistant surgeons and overseers, serving the requirements of the colonial job market. Trivedi realized that this' mechanization' could not altogether be avoided. It was part of the global change. That is why he did not become a Gandhi and attack the West with anything he could lay his hands on! Trivedi kept grappling with the two different texts. He would accept modernity but not westernization; modern university system of education but not its commercialization. Several Indian thinkers and reformers of his age like Vivekanand and Aurobindo held similar views. But Trivedi was slightly different in the sense that he was deeply aware of the philosophical issues concerning science and scientists. Nevertheless, he would deny modern science any epistemological superiority (unlike P .C. Ray). He would rather describe western scientists in Hindu terms; for example Copernicus as one with Dibyachakkhu (spiritual vision), Newton as a Rishi (sage), and Helmholtz as an Abatar (incarnation). [45]

In contrast, the two most creative scientists that late nineteenth century India produced, J.C. Hose and P.C. Ray, would fully accept the epistemological superiority of modern science, and both treated education as the most effective vehicle for assimilation and gradual diffusion of the new ideas. Both were well-steeped in Indian history and culture, and could discriminate between what was to be taken and what not. J.C. Bose was a bio-physicist who worked on the 'electrical impulse and response in the living and the non-living.' Borrowing from the technical language of his discipline, he described the role of education in the East-West encounter in the following terms:

An impulse from the outside reacts on impressionable bodies in two different ways, depending on whether the recipient is inert or fully alive. The inert is fashioned after the pattern

of the infinite repetition of one mechanical stamp. But when an organism is fully alive, the answering reaction is often of an altogether different character to the impinging stimulus. The outside shocks stir up the organism to answer feebly or to the utmost in ways as multitudinous and varied as life itself. So the first impetus of Western education impressed itself on some in a dead .monotony of imitation of things Western; while in others it awakened all that was greatest in the national memory. [46]

Unlike P.N. Bose and P.C. Ray, J.C. Bose did not undertake any investigation into the 'national memory' (i.e. history). But he did try to identify his works with what he considered to be 'greatest' in his cultural inheritance. His propositions that life emerges out of non-life and that there exists an underlying unity between the living and the non-living, were taken as scientific manifestation of the Sarnkhya philosophy. J.C. Bose used to quote from the Vedas and had a poetic flavor; he even gave Sanskrit names to his instruments and did not see any conflict between science and religion. The contemporary opinion did not consider him mystical or oriental; rather he was hailed as a synthetic mind. [47] His works were the first authentic rebuttal of the colonial view that Indians were incapable of original scientific investigations. But his was not an ivory tower projection of education and research. He was convinced of the utilitarian value of science and wanted its wide-spread diffusion through proper science education. It had to be not only for the sake of scientific knowledge but 'also to harness the economic resources of the country and to show how to discriminate between industries which can and which cannot be profitably carried on under the climatic and other conditions prevailing in India.' [48] To achieve this one needed a 'satisfactory' science course, good laboratories and scholarships'. Bose was particularly perturbed over the science curriculum in Indian universities. At the graduate level in Calcutta University, for example, the vast area of acoustics, heat, light, electricity and magnetism formed only half a paper! To add to the woes of the students too many textbooks were prescribed. The result was they looked for help books. Second hand knowledge thus took the place of 'living science.' Even this could not be put to any use because, in the absence of any post-degree scholarship or employment, they would shift to a career in law or administration. Like his compatriots, Bose excelled in diagnosis but his solutions were limited and heavily dependent on government. All through he remained a devoted researcher, not an activist.

P.C. Ray, on the other hand, showed a higher degree of social commitment. He was an educationist, a scientist, an entrepreneur, a Gandhian activist -all rolled into one. He spoke and wrote extensively on educational matters with rare passion, sincerity, and clarity. Himself a working scientist and deeply conscious of its industrial applications, he was one of the earliest to

see science in its social context, to talk of its social relevance and accountability. He did some original research in India's scientific heritage and attempted a social explanation of what went wrong when and how. Unlike Trivedi and others, he held the Indian social and caste structure responsible for the cleavage between mental and manual work and the resultant stagnation. [49] He wanted modern education to bridge this gulf. In his view education has to be quality oriented; not for degree but for generation of employment and wealth. The average graduate was found to be 'a licensed ignoramus', and the degree itself served as 'a cloak to hide the degree-holders ignorance'. Higher education should be limited to only those who feel 'an instinctive call in that direction.' [50] The other great defect in his opinion was the undue stress on a literary curriculum. A Calcutta University student for M.A. degree in 1930 had to attend 230 classes in English, and only 65 in mathematics. He was equally unhappy about the intellectual narrowness of the specialist in science. He envisioned a broad 'mental culture' in which science, literature, history, and philosophy were to be given almost equal attention. Legal studies which thrived on the colonial requirements had no place in this scheme. Gandhi had severely criticized the legal profession. Similarly Ray would exclaim, 'if I am made the dictator of the university for one day, I would shut down the Law Department for at least three years!' Apart from the defective curriculum what hurt Ray most was the medium of instruction. He was convinced that learning through a foreign medium killed originality.

Imagine for a moment what would happen if the English lad were compelled first of all to learn Persian or Chinese or say German or Russian and then had to read through the medium of such a tongue.... in India we have adopted the most unnatural system and have to pay a heavy penalty for it. [51]

Ray realized that his own forefathers had gone 'mad' over English education but he appreciated their dilemma. In the first half of the nineteenth century English education was necessary to acquire new knowledge. Rammohum and Vidyasagar who asked for it, had also written extensively in Bengali. Later the whole process degenerated into a 'service-seeking mania.' This Ray resented. He was not against English. He only asked for its late introduction, after the mother tongue had laid the base. J.C. Bose held similar views and recalled with pride how his father had sent him to a' vernacular' school. This did help him relate to his surroundings. But higher education and publication of research had to be in English, the language of the scientific world. [52] They had no doubt about it. Then the existing institutions of science education and research had to be strengthened through fellowships, laboratories and private donations. When J.N. Tata (a leading Bombay merchant) floated the idea of an Indian

Institute of Research, Ray was reticent. He would have preferred private munificence to encourage the existing institutions in different parts of the country rather than create one single island of excellence. He argued 'India is not a compact, homogenous country, like Japan; a central Research Institute with an "Imperial University" like that of Tokyo, does not seem to commend itself.' [53] Later in 1931 when the eminent engineer M. Visweswaraya pleaded for a Technological University, Ray called it a delusion. 'In every country industrial progress has preceded progress in science and technology'. [54] In this industrial progress he envisaged a greater role for the businessmen and workers than the graduates in science and arts. The key to prosperity allegedly relied on the spirit of entrepreneurship and not on mere technical expertise.

Ray did not advocate higher education for everyone but primary education was a different matter. As late as 1934 the Bengal Government was spending only 27 lakhs on primary education while it raised 32 crores of rupees as revenue from the province. It was a mere 0.9% of its earning while Japan and Denmark spent about 20% of their gross revenue on primary education. Ray cited from the Famine Commission of 1880, the Agricultural Conference of 1888, etc. on how beneficial primary education would be for the peasants. Millions perished in epidemics, and the ignorant masses, steeped in superstition, looked to goddess Sitala. It was useless 'to din Pasteur's researches into their ear.' Ray would argue, 'an ignorant people and a costly machinery of scientific experts go ill together.' He shared the belief that 'it is education, and nothing but education, that can remove social evils, sanitary troubles and economic distress from the country, and can awaken political consciousness and create social solidarity in the people. Self-government without literacy would be nothing but a farce, and might possibly be a tragedy.' [55]

CONCLUSIONS

The above details show that the voluntary associations and individuals played perhaps a more important role in the gradual emergence of Calcutta as a science city than direct government efforts. But government patronage was important. The establishment of scientific institutions and journals was dictated not so much by the diffusion of scientific knowledge per se as by the local management of the complex resources of the colony. The government, that too of a trading company, would naturally be guided by economic considerations. But there was no guarantee that scientific excellence would bring economic benefits. Science came to be valued more as a cultural activity. The government asked its officials to undertake such pursuits only in

'leisure' time. Researches thus were individualistic and esoteric, the only binding cord being the scientific 'clubs'.

Another important aspect is that the practice of science remained largely alienated from its social context. In fact, one may ask, was it culturally divisive? Some found cultural dependence quite unavoidable, while others rejected colonialism entirely and searched for identity in indigenous traditions. The spread of modern science required the penetration of indigenous science and culture by western science. Many Calcuttans responded enthusiastically. Was it because the bhadralok wanted to legitimize their newly-won status or was it a true craving for knowledge and improvement? The truth perhaps lies somewhere between the two.

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[2] Roy MacLeod, "On Visiting the Moving Metropolis: Reflections on the Architecture of Imperial Science", Historical Records of Australian Science, 5, no.3 (1982): 1-16.

[3] Deepak Kumar, 'India', in Roy Porter (ed.), Eighteenth Century, (Cambridge University Press, 2003):669-687.

[4] A. Rahman (ed.), Science and Technology in Medieval India: A Bibliography of Source Materials,(New Delhi: INSA , 1982), 494. See also, C.A. Storey, Persian Literature: A Bio-bibliographical Survey, vol.2, pt. 2 (London: Royal Asiatic Society, 1971), 410.

[5] A. Rahman, Ibid, 333.

[6] Frits Staal, Concepts of Science in Europe and Asia, (Leiden: International Institute of Asian Studies, 1993), 26.

[7] Quoted in Irfan Habib, "Capacity of Technological Change in Mughal India", in A. Roy and S.K. Bagchi (eds.), Technology in Ancient and Medieval India, (Delhi: Sundeep Prakashan, 1986):12-13.

[8] L.L. Fermor, Year Book of Asiatic Society of Bengal for 1934, vol I (Calcutta, 1935), 16.

[9] Savitri Das Sinha, Academic and Professional Journals, TS.

[10] H.H.Risley, "Presidential Address", Proc.of the Asiatic Society of Bengal, Jan.6,1904, p.26.

[11] Nature, vol. LXXV, March 28, 1907, p. 511.

[12] Medical Selections, I, Calcutta, 1833, pp.III-IV

[13] Transactions of the Medical and Physical Society of Calcutta, III-V, 1827-1831.

[14] The prospectus of this Association was published in the Calcutta Journal of Natural History, 1841, pp. 8-14

[15] Howell, Arthur, Education in British India, Calcutta, 1872, p-5.

[16] For Miraculous details see, Griffin, H.M., T.B. Macaulay and the Anglicist- Orientalist Controversy in Indian Education, (unpublished Ph.D. thesis, Pennsylvania University, 1972), 11.

[17] Ibid, 488.

[18] Home, Public, July 8, 1835, no.4 (all archival references unless otherwise indicated are from the National Archives of India).

[19] The Hurkaru, April 28, 1838, also quoted in The Calcutta Monthly Journal, XLVII, Oct. 1838, p. 206.

[20] The Centenary Volume of the Medical College of Bengal, Calcutta , 1938, p.12

[21] 125th Anniversary Souvenir of the Bengal Engineering College, Shibpu, 1981, p. 1

[22] Home, Public, Sept. 13, 1845, nos. 19-30

[23] Mouat, F.J., Proposed Plan of the University of Calcutta (Calcutta, 1845), 57-62.

[24] Selections from the Records of Govt. of India no. LIV (Calcutta, 1867), 11.

[25] West Bengal Archive, General, Education, Aug. 1860, no.90.

[26] Calcutta Monthly Journal, Voll. III, 1837, p. 826.

[27] Ghosh, Benoy,Samayikapatre Benglar Samajchitra, Vol. IV (Calcutta, 1966), 530, and the Athenaeum, no. 2168, May 15, 1869, p.672

[28] Nature, Vol. V. April 25, 1872, p.510. Most of the professors were Oxford or Cambridge graduates, who sought to impart to the Indians such an education as they had themselves received, Murdoch, J. Educational Reform, (Madras, 1893), 2.

[29] Note by E, C. dt. 10th Jan. 1886, Home, Educations, Oct, 1897, Nos. 14-88, Pt. B.

[30] Croft, A., Review of Education in India, (Calcutta, 1888), 147

[31] DPI Report, Bengal, 1891-92, (Calcutta, 1892), 5.

[32] Minutes of the Calcutta University, 1898-99, para 331, Members of the Science Degree Committee were J. C. Bose, E. Lafont, Mahendra Lal Sarkar, A. Pedler and P.C. Ray.

[33] Quoted in, A Century: Indian Association for the Cultivation in Science (Calcutta, 1976), 5 (emphasis added).

[34] Bhattacharya, B. Banga Sahitye Vigyan, (in Bengali) (Calcutta,1960), 144-5.

[35] 'The Danger of the New Century', The Pioneer, Jan. 28, 1901~ 'Good Bye 1800- 1900, The Statesman, Jan. 4, 1900; K.Zulaskar, 'India entering upon a new era of enlightenment', Modern Review, 21, V, 1913, pp.535-38.

[36] 'Lord Curzon 'on Higher Education', The Dawn, 25 Dec., 1900.

[37] As a recent work argues, 'it would be erroneous to conceive Swadeshi's nativism as an atavistic upsurge of a reified tradition in the face of modernization. Rather , nationalism's nativist particularism must be situated within a broad understanding of the perceived decentering dynamic of capitalist expansion. ' Manu Goswami, 'From Swadeshi to Swaraj: Nation, Economy, Territory in Colonial South Asia, 1870- 1907', Comparative Studies in Society and History, 40, no. 4, (1998): 609-637.

[38] Note by H.B.Medlicott, Director, GSI; National Archive of India, Revenue- Agriculture, Surveys, proc. no.25, Sept. 1880.

[39] P.N.Bose, A History of Hindu Civilization, vol. III (Calcutta, 1896), II-V and 98.

[40] P.N.Bose, Essays and Lectures on the Industrial Development of India (Calcutta, 1906), 65-85.

[41] Prophetically be wrote, 'the great wars of the future will be fought not for interests in Europe, but for interests outside Europe'. Ibid, 241-258.

[42] P.N.Bose, Swaraj, Cultural and Political (Calcutta: 1929), 275-76.

[43] R.N. Trivedi quoted in, Santanu Chacraverti, Ramendra Sundar Trivedi and Bengal's Response to Modern Science (unpublished Ph.D. thesis, Jadavpur University, 1996), 42 and 80.

[44] Ibid, 85.

[45] Ibid, 183.

[46] Modern Review, Feb. 1917, reprinted in D.Sen and A.K.Chakraborty (eds), J.C.Bose Speaks (Calcutta, 1986), 31-32.

[47] The Dacca Review, vol. VI, Dec. 1916, in J.C. Bose Trust Press File no.2, 247.

[48] The Englishman, May 22, 1897, in J.C. Bose Trust Press File no.1, 58.

[49] P.C.Ray, History of Hindu Chemistry, 11, (Calcutta, 1909), 195.

[50] P.C.Ray, Life and Experiences of a Bengali Chemist (Calcutta, 1932), 261-299.

[51] Ibid. 289.

[52] Those who were not too happy with J.C.Bose (probably Sir Asutosh Mukherjee) would make fun of his professed love for the mother tongue: 'Why does not Sir Jagadish publish his original articles in Bengali? Who knows, there may flock in Bengal, thousands of devotees from the remotest corner of the earth to learn the Bengali language. The Century Review, Jan. 1918 in J.C.Bose Trust Press File No.F/94.

[53] P.C.Ray, 'The Problem of Scientific Education in India'. Calcutta Review, CVIII, (1899): 347-395.

[54] P.C.Ray, Life and Experiences, 321.

[55] Ibid., vol.II, 82-100.

Technology and totalitarian ideas in interwar Greece

By Yiannis Antoniou / Vassilis Bogiatzis*

This paper is an account of modernity, technology and totalitarian ideology in interwar Greece. We argue that the challenge of modernization and technological development of the country was the starting point for the emergence of technocratic ideas strongly connected with nationalism, a kind of a Greek technonationalism. Scientific objectivity, technological efficiency, rationalization, were to be part of the "eternal" national essences, and they were conceived as key elements for the rapid modernization and westernization of Greece. The instrumental idea of progress, as well as the requirement for technological development, was gradually correlated with criticisms of economical and political liberalism and the rise of control and totalitarian ideas. The anticipation for an effective organization of society should be assimilated trough homogenized standards of factory production. As stated by the sociologist P. Wagner, the image of the society as a machine was a rather trivial idea for the time and the "iron cage" metaphor didn't represent a social threat.[1]

The Greek Republic and its emerging civil society, the economical and political crisis in the beginning of the 1930s, the dictatorship in 1936-1941, provide the framework within which the rise of tensions about modernity and technology took place. In a schematic way, we can understand this ideological course with respect to ideas about rationalization, technology and modernity as a trajectory from liberalism and moderate corporatism to the orthodoxy of technocracy, and from there to a Greek version of a so-called reactionary modernism.

After the Balkan wars and the First World War, Greece no less than doubled its population and territory.[2] The expansion of the country was translated in the expansion of public works, new structures of administration and expansion of the engineering professions. All these were strictly connected with the modernizing visions of the Liberal Party and its leader - Eleftherios Venizelos- as well as with those expressed by the Army that actually dominated the country from 1910 to 1932.

A brief political account is necessary in order to sketch the general context. Venizelos first came to power in 1910. The social and political reforms of liberals as well their strong irredentism, in respect of territorial expansion of the country in Asia Minor and Thrace, where

Greek population lived, resulted in a strong political dispute with the Greek monarchy and its political adherents. In 1915, Venizelos confronted King Constantinos regarding the participation of Greece in the World War I; this conflict resulted in the expulsion of the liberals. The latter resumed power in 1917 with the decisive intervention of the western allies (Entente). In 1920, the conservative coalition won the elections. In 1922, the conservatives were again overthrown after the defeat of the Greek army in the Greek–Turkish war and the violent expulsion of the Greek population from Asia Minor by Turks nationalists, under the leadership of Mustafa Kemal Ataturk. In 1924, the coalition of liberals, having the support of the army, abolished the monarchy and established the Greek Republic. The turbulent starting point of the Republic stamped its short life. From 1924 to 1928, 9 parliamentary governments, 6 military coups d'états, and one dictatorship took place. In 1928, Venizelos again became Prime Minister and ruled the country until 1932.[3]

The institutional landmarks of the period in the field of technology, public works and industrial development, were the establishment of the Ministry of Transportations, the rise of the Polytechnic School of Athens to the Academic level, and the establishment of the Technical Chamber of Greece. These three institutions, strongly correlated, were to become the main official representatives of the technocratic ideologies in its variety of versions during the interwar period.[4]

The Ministry of Transportation was established in 1914. The new institution reshaped and extended the state bureaucracy introducing modern regulations in regard of administration and construction of public works. The upgrading of the Public Works Administration to the level of a Ministry became the symbol for the upgrading of the social role of engineering professions. In this context the main problem was not any more just the railways, the electrification, the reclamation or the road construction projects but the management of the emerging and extremely complex political society according to the rational terms of engineering.

In that same year the Polytechnic School became the academic equal to the University of Athens and was renamed National Technical University of Athens (NTUA). According to the new regulations, which were applied gradually until 1917, five separate schools were established. The School of Civil Engineers, the School of Mechanical and Electrical Engineers, the School of Chemical Engineers, the Architecture School, and the School of Surveying Engineers. The NTUA, under the leadership of a group of professors who had studied in Germany, would adopt the German model of higher technical education.

The momentum of the engineering profession was intensified by the emergence and the development of the first professional engineering institutions, which in 1923 led to the establishment of the Technical Chamber of Greece. The Chamber was not only a corportatist organization with mandatory membership representing the engineering profession, but it was as well an official technical consultant arm of the state. The first role opened the way to the official closure of the profession at the beginning of 30s reinforcing its elite professional identity. The second inspired and legitimized the several versions of the technocratic ideal expressed by the Greek engineers.[5]

In this context, the technology issue was upraised both as the pioneer of progress and economic development, and as one of the main foundations of the social regime. At the end of the 20s the prominent liberal intellectual Giorgos Theotokas declared that "…in the Balkans which existed for many centuries as one country with an almost single civilization, contemporary Greece signs out of tune, throwing out at once all her Byzantines and Balkan traditions and questing for a new orientation...".[6] He was convinced that technology has hidden and unexplored poetic opportunities: "This 'materialist and banal' century hides in his unexplored soul much more poetry than our teachers believe. But, someone must attempt to discover it. It's time for risky sappers".[7]

Prime Minister Venizelos was also thinking that technology would be the foundation of economic development and social stability. A recurrent point in the Venizelian appropriation of technology was the following motive: the construction of infrastructures in rural areas of the country would increase the area of cultivable land. Such a development could increase national wealth and satisfy the peasants as well, empowering the country and the social regime. In this context, the peasants who constituted the vast majority of the Greek population would allegedly distance themselves from working class movements that menaced to undermine the social and political system.[8]

This positive attitude in respect to technology was materialized in the extended program of public works of Venizelos' government (1928-1932): a road network, land reclamation works, electrification, sewage systems, programs for public health and housing, and refugee's settlement projects.[9] In contrast, although industrial productivity steadily increased during the interwar period,[10] the extended industrial development did not appeal to liberals' major priorities.[11] Only when the Depression came to Greece, did the State decide to protect industrial production. Nevertheless, industry was not considered as the steam-engine of the economic

progress as it was mainly orientated to the domestic market and it was rather subjected to the agricultural development.[12]

The main stream in respect of technological development and industrialization of the period was expressed by a group of industrialists, under the leadership of a handful of engineers who had studied in the Polytechnic of Zurich (Eidgenössische Technische Hochschule). These men were closely connected with the establishment of the big chemical, cement, electrical, and construction industries in Greece. They decisively contributed to the social and institutional formation of the Greek industrialist class and they would eventually become the luminaries of Greek industrialization during the inter–war period.

This group praised the spirit of industrial rationalization and mechanization; they became the outspoken disseminators of Taylorist and Fordist ideas, and expressed the value of individuality strongly resembling the American entrepreunal ideal. They tried to pacify the fears of several social groups and to confront the critique of the romantic intellectuals, who considered industry and the emerging civil society as a threat to the social coherence. In doing so, the "Zurichians" and their friends adopted the ideological principles of social paternalism and contrasted it with the ideology of class struggle, which the Communist Party and the labour unions projected.[13]

In the beginning of the 30s, when the 1929 world economical crisis came to Greece, the same group tried to accommodate itself to the new framework supporting a type of directed economy, based on protectionism and state control. At the same time, the viability of the country and the question of industrial development came to be a crucial component in public debates. Those who defended industrial and technological development and advocated rationalization were challenged by skeptics for whom machines, industry, economic and political liberalism, were targets of an anti-capitalist and anti-industrial critique that had strong romantic hues. What fuelled the critique was the idea that Greece was, and ought to remain, an agrarian country. Giorgos Theotocas criticized once more the liberal ideas that were freely tested in Greece during this period. He wrote about the "mad decade of the 1920s", characterized by the "absence of any kind of moderation, any discipline and prudence in respect of politics, economy, ethos and cultural activities." According to Theotokas, economic liberalism, unbounded individualism, industrialization, and the sovereignty of machines resulted in a social disequilibrium. The crisis of capitalism led societies to the disease of communism which was presented as the apotheosis of materialism and the integration of society with Machine Civilization.[14]

In this context, the engineers intervened in an impressive way through a large-scale forum called "The major research for technical and economic issues" organized by the Technical Chamber. They declared the country's ability for a viable economic development through industrialization and rationalization of everything. This forum began in December 1931 and lasted for 5 months. It was attended by political parties' leaders, members of the parliament, while more than 40 politicians, economists and engineers from Greece and abroad presented papers.[15] The controversy took place in a context marked by strong critique against economical liberalism. The metaphysics of the market was replaced by the metaphysics of state regulation; the vision of liberal modernity was gradually replaced by the vision of control; and the value of individuality replaced by collectivity. The end result was a strong version of the autarky ideal, approaching a notion of economical nationalism.[16]

Already at the end of the 1920's, and especially during the crisis era, political reforms inspired by the ideal of control and restriction of classical liberalism were intensified.[17] The establishment of the Council of State had a prominent place in this set of institutional technologies. It was strongly connected with the requirement of the rationalization of state administration and politics, and it was expected to play an active role as mediator between the state and society.[18] The Supreme Economic Council, legitimized by the rhetoric of scientific expertise, was constituted to work as a supplement of parliamentarism in order to confront the complexity of the social conditions.[19] The other institution was the Senate, which was expected to guarantee political stabilization and to appease the social strife through a kind of corporatist representation of professions and social classes.[20] To complete the institutional framework, we should add the so called Idionimon Law, aiming officially to protect the social regime and to restrict communism. Other legislation institutionalized the compulsory state arbitration in cases of strike and lock-out, as well as the prohibition of public servants' syndicalism, aiming to harmonize the different social interests and to suppress the political expressions of the working movement.[21] Finally, in 1932, a constitutional reform, which was never realized, was orientated to the reinforcing of the government authority and the restricting of parliamentary jurisdiction.[22]

In 1932, the monarchists won the elections, opening the agenda of a strong political crisis, which ended the Republic and the parliamentary system in 1936. In any case, strong debates among intellectuals and politicians, representing the largest part of the political spectrum, stressed the inefficiency of parliamentarism to confront the crisis. The confrontation over parliamentarism or dictatorship became extremely strong in the political controversies of

the time. Between 1933-1935 three military coup d'états deteriorated the political situation and intensified the demand for authoritarian solutions.[23]

In this complex juncture new ideological syntheses were projected among engineers. The Technical Chamber of Greece, under the leadership of Nikos Kitsikis, a leading figure among interwar Greek engineers, elaborated an ideology that started from a modest corporatism in 1931 and gradually developed, by 1935, to a version of a technocratic totalitarianism, strongly resembling the orthodoxy of the Technocracy movement. The selected field for the fulfillment of this utopia was the real world of the state bureaucracy and public works – and the (approximately) 2000 engineers who worked there. According to this synthesis, state, profession, and science, were to be integrated in a unique rational apparatus which would claim political hegemony and guarantee the controlled modernization of the country in terms of rationalization and technological development.

The Chamber's rhetoric castigated the paralysis of the parliamentary system and the inefficiency of politicians who could not understand the rational dictates of the new machine age. Words and pictures filled the pages of the Chamber's journal, Technica Chronica, praising Fritz Todt's highways, Julius Dorpmuller's trains, Albert Speer's stadiums, and Mussolini's foundries. These artifacts were taken as the materialization of the progress ideal and political efficiency; they enabled the full integration of technology and politics and constituted an assertive argument for the pre-eminence of technocratic totalitarianism. By 1935 the idea was mature and the parliamentary system was overtly seen as an obstacle.[24] The solutions to the socio–political problems and the technological development of the country could be carried out only through social engineering and the establishment of a "Technical State", actually a rational dictatorship of engineers, which resembled Thorstein Veblen's and Howard Scott's utopias.[25]

The long term political and social crisis ringed out the end of the Republic and paved the way for the restoration of the Greek monarchy by late 1935, and after this to the dictatorship of Ioannis Metaxas proclaimed the 4th of August, 1936.

In the mid thirties the modest corporatism and statism were no longer enough to guarantee a way out from crisis and to legitimize the technocratic ideal. The contingencies of liberal modernity were getting more and more unbearable; at the same time, the return to the certainty of control was getting more and more fascinating to the social imagery. According to Theotokas "… the State must be ready to take up its major role in the political and economical life, to undertake more responsibility and to be more efficient in confronting the social

problems, to be emancipated from the misery of parliamentarism compromises in order to achieve the efficient management and the harmonization of the contradictory social interests"[26].

An emancipated ideal of economical and technological progress in association with a strong civil society looked now as dangerous as communism. The confrontation to materialistic modernity, perceived as the main cause of the crisis and social revolt, presupposed the subordination of technocrats to the power of national ideals and values. The ideological context of this subordination was based on a rich Greek traditional inheritance, and a variety of foreign ideological influences.

Many Greek engineers, namely those who studied in Germany, were influenced by what J. Herf calls reactionary modernism[27] or, according to M. T. Allen and E. Todd, a broadened idea about modernism.[28] They tried to replace Nibelugen's swords and Wagner's Valkyries with Parthenon's ancient glory, and doing so they invigorated the already strong idea of techno-nationalism.

The consensus on the domestication of rationalism and technology by the metaphysics of faith legitimized the perspective of the technological and industrial development of the country supported by engineers. It gave them strong advantages in their competition with the classicist, romantic and technophobic intellectuals, and the adherents of the traditional culture.

The dictator I. Metaxas, as an ex military engineer, who always liked to speak from his heart in terms of faith, took over what the industrial mania of the group of Zurichians and the rational technocratic utopia of Kitsikis could not accomplish. The absence of political and trade union liberties made the accumulation of capital a much easier affair. The so called "productive public works", which had been stopped after the crisis in the early 30s, restarted. The big projects of road construction and land reclamation, as well as the construction of the bunkers at the northern borders of the country in the late 30s, were accomplished to a large extent during this period. Due to the efforts of the Technical Chamber, the projects were assigned to Greek companies and engineers. At the same time the Greek industry was developed on a protectionist basis. Evidence of this inclination are the big lignite exploitation projects, the reports about hydroelectric infrastructures, the state factory for airplanes, the military shipyards, and the plans for the establishment of a steel industry in Greece just before the war. The share of industry into the gross national income was finally increased from 11.45% in 1928 to 13.42% in 1939.[29]

The board of the Technical Chamber, evaluating the economical and technological policies of the regime in 1939, commented: "The engineers…as intellectuals and pragmatists understand very well that the globalization of science and politics, in a context of strong

contentions, can not guarantee secure life and prosperity. The only resort for individuals is to belong to a coherent and strong national family".[30] Metaxas responded and stressed with emphasis: "…I want to thank every one of you for your support to the 4th of August regime, which has already born some fruit."[31]

Social paternalism, autarky ideology, and totalitarianism, empowered by the essentialist reconstruction of the national past, became the tools for the cleansing of the technocratic ideal from its materialistic ingredients and protecting as well social hierarchies from the threat of the class struggle. These ideas were the framework of the alliance among engineers and the 4th of August regime. The regime used and empowered this ideological synthesis and legitimized the perspective of the industrialization in a context of what it was called the 3rd Greek Civilization (actually an ideological construction of a linear continuity from ancient Greece to Byzantium and Christian Orthodoxy, and from there to the modern Greek nation state).[32]

Metaxas' authoritarian regime (1936-1941) claimed the identification of the state with an image of a coherent society.[33] Doing so, it actually followed and broadened the control inspired rhetoric, legislation and institutional formation, which had already started during the liberals and conservatives' parliamentary governance. The regime claimed an ideal harmonization between capital and labor, through the development of a kind of an authoritarian welfare state,[34] the attempt for the corporatist organization of society and the compulsory state arbitration.[35] Moreover, the Supreme Economic Council maintained its previous jurisdictions.[36] Metaxas also aimed to complete his political vision with a radical constitutional reform, which would permanently legitimize his regime with all its authoritarian characteristics.[37]

Metaxas' outspoken technophilia was based on his belief for the doubtless contribution of technology to the social progress. As Minister of Transportations during 1926-1928 he had already declared: "The roadwork network being conceived as a common creation of all Greeks, I am absolutely convinced that it will constitute one of the most beautiful stages of the development of the Greek working class, Greek entrepreneurship, Greek development, and finally, of the Greek civilization in general".[38] But, as the dictator said, in order for technology to function in such a way some preconditions were necessary.

First, technology and science should be incorporated to the authoritarian State. Such a solution should be multiply advantageous for the techno/science development, because it would not only facilitate the realizing of technological works, but it would also infuse social solidarity and national grandeur into soulless technological networks. It could finally motivate the techno/science activity in order to contribute to the progress of the national community, the

moralization of society, and the deeper foundation of the national idea: "And now we are able to trustfully aim towards the full development of this country. Through the development of transportations, the civilization, the people's wealth, the communication among habitants, the solidarity and connections among them will be also developed… However, if by this work it is the material civilization which is advanced, you have to remember that the existence of a real and durable civilization in one country must be based on a higher moral level. Is it necessary for me to tell you which moral civilization is this? Of course no..."[39]

Metaxas asserted that technology should be subordinated to the fundamental principles of the 4th of August regime: the values of religion, fatherland, loyalty to the family, the formation of a new moral civilization incarnated in the solidarity among citizens, in loyalty to the State and the king, and the edification of the youth through the subjection to the eternal moral rules.[40] Given that for Metaxas the authentic essence of science was faith and not reason, he believed that science and technology should be imbued with it: If you have not deep inside this faith you cannot become real scientists. How can you find something which you don't believe that really exists? But, what does such a belief order you? It orders you to be real in all the dimensions of your life. How is it possible for a scientist to be a researcher for truth, if the same man is a liar in his life?"[41]

Moreover, science and technology should be subjected to national ideals: "Your intellect must be destined to the development of the pure science… Because Greece is the country which created the modern European civilization and science, you must feel proud of it and serve with faithfulness the international science, but you must do it as Greeks, the way that your ancestors did, with the same devotion, the same zeal, and the same sacrifice".[42]

This was projected as a precondition in order to avoid negative effects from the uncontrolled evolution of science and technology. So, scientists and engineers were forced to support the idea of the national State as the only meaningful ideal for them.[43] At the same time, although technological civilization was conceived soulless per se, Metaxas declared that, through its subordination to the eternal essences, it could meet a higher level of spirituality and morality.[44]

He said: "I know very well that the scientists, unlike me, are influenced by rationalism; they use observation and experience instead of faith. I don't want to keep secret from you that the basis of my interaction with the people is the inspiration of faith and not rationalism, neither any experience nor experiment. But if you ask me what the keystone of this faith is, I will have to admit, I am ignorant".[45]

Summarizing, the technology question came to be an organic component to the ideological debates of interwar Greece, inextricably connected with ideas about modernity and progress. In this discursive framework, technology emerged as a crucial cultural variant related with moral and national existential issues. Politicians, engineers, scientists, and intellectuals were actively involved in these debates aiming to connect technological development with the necessity of a response to the acute social and political crisis.

Posed in this frame, technocratic ideals, as well as the instrumental representations of progress were increasingly interacting with authoritarian ideological orientations, which implicitly or explicitly undermined the liberal ideal in economy, society and politics. Politicians, engineers, and intellectuals, despite their differences, articulated a homogeneous commitment to the idea of order and discipline, contributing to the end of parliamentarism. The heyday of this evolution was the domestication of technocrats to the essentialist declarations of the authoritarian 4th of August regime. Their subjection to the regime was the price which they had to pay in order to legitimate and promote their technocratic visions.

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[1] Wagner, Peter. A Sociology of Modernity, Liberty and Discipline (London: Routledge, 1994), 37-69.

[2] In 1836 the population of the new founded Greek state was about 818.582, within a territory of 47.516 km2. The borders expanded twice over the period 1832-1912; in 1864, when Great Britain ceded the Ionian Islands to Greece, and in 1881, when Thessaly and part of Epirus were annexed. In 1907 the population of Greece was 2.631.952 and the extent of the country was 63.211 km. Petmezas, Socrates, "Demography", History of Greece in the 20th Century. The Beginning, 1900 1922, v. A1 (Athens: Vivliorama, 2000), 42-43 (in Greek).

[3] Dafnis Grigorios. Greece Between two Wars, vol. A (Athens: KAKTOS, 1997, 2nd ed.) (in Greek); George Mavrogordatos, Stillborn Republic, Social Coalitions and Party Strategies in Greece, 1922-1936 (Berkeley: University of California Press, 1983); Gunnar Hering, The Political Parties in Greece, 1821-1936, vol. B' (Athens: MIET, 2004), 1046-1254 (in Greek).

[4] Yiannis Antoniou, Greek Engineers, Institutions and Ideas (1900-1940), (Athens: VIVLIORAMA, 2006), 126-140, 150-164, and 181-193 (in Greek).

[5] Antoniou, Greek Engineers, 301-353

[6] G. Theotokas, Free Spirit, (Athens: ESTIA, 2002, 1st edition 1929), 6 (in Greek).

[7] Ibid, 69-70.

[8] Christina Agriantoni. "Venizelos and Economic Policy", P. Kitromilides (ed.), Eleftherios Venizelos: The Trials of Statesmanship (Edinburgh: Edinburgh University Press, 2006): 284-318.

[9] S. Tzokas, S. Eleftherios Venizelos and the bourgeois modernization project 1928-1932: the construction of a bourgeois State (Athens: Themelio, 2002) (in Greek).

[10] Mark Mazower, Greece and the Inter-War Economic Crisis (Oxford, Clarendon Press, 1991); Nikos Psiroukis, Fascism and the 4th of August Regime (Lefkosia: Aegean publications, 1994) (in Greek); Th. Veremis and M. Mazower, "The Greek Economy 1922-1941", Th. Veremis and R. Higham. (eds), Aspects of Greece, The Metaxas Dictatorship (Athens: ELIAMEP-Vryonis Center, 1993): 111-130.

[11] Kostas Kostis, "The Greek Economy during the Depression", Th. Veremis and G. Goulimi (eds), Eleftherios Venizelos, Society-Economy-Politics in his era (Athens: Gnosi, 1989): 191-226 (in Greek); Christos Hadjiosif, The Old Moon, The industry in Greek economy, 1830-1940 (Athens: Themelio, 1993) (in Greek).

[12] Kostas Kostis, "The economy challenge: Facing the international economic crisis", Th. Veremis and E. Nikolakopoulos, (eds), Eleftherios Venizelos and his era (Athens: Greek Literature editions, 2005): 331-340, (in Greek).

[13] Antoniou, Greek Engineers, 177-181, and 371-375

[14] G. Theotokas, "Facing the Social Problem", Alivizatos, N. Tsapogas, M. (eds), G. Theotokas: His Political Thought (Athens: Estia, 1996, 1st edition 1932), 170-197 (in Greek).

[15] The Economical Inquiry of the Major Technical Issues (Athens: edit. Technical Chamber of Greece, Athens, TEE, 1933) (in Greek).

[16] Ch. Chatziiosif, "Aspects about the Viability of Greece and the Role of Industry', Volumes Dedicated to N. Svoronos, v. 2 (Heraklio: PEK, 1986), 330-368 (in Greek).

[17] Nikos Alivizatos, Political Institutions in Crisis: The Greek Experience, 1922-1974 (Athens: Themelio, 1995), 21-29, 33-134, 337-346, 673-695 (in Greek).

[18] St. Stefanou, St. (ed.), Eleftherios Venizelos.: His political inheritance (Athens, 1971-1981), 2nd Volume, p 439-442, 3rd Volume, p. 398, 549, 576; 4th Volume, p. 188-189 (in Greek). Archives of Eleftherios Venizelos, FO 173/141 (in Greek). Although the Council of State was probably constituted as a modernizing institution, its judicial dimension prevailed over the administrative one. The powerful State maintained the political control. See also, N. Alivizatos, "Council of State: An institutional paradox?", Chr. Chatziosif, (ed.) History of Greece in 20th Century: 1922-1940, vol. 2 (Athens: Vivliorama, 2002), 245-257 (in Greek).

[19] According to Venizelos and the majority of Greek politicians, the incapacity of the parliamentary system to confront the complexity of the times made absolutely necessary the system to be empowered with scientific institutions in order to handle the economic and technological problems in a scientific context. The Supreme Economic Council was expected to contribute in solving the problems and harmonizing the different social interests within a cohesive national context. Finally, its role came to be strictly conciliatory and it was not transformed in a kind of parliament of professional interests Archives of Eleftherios Venizelos, FO 173/142, 173/145, 173/146. See also, Hering, Political Parties, Volume 2, 1153-1154. Kostis, "The Economy challenge", 331-340.

[20] Stefanou, Eleftherios Venizelos, Vol. 1, 188-189, 206, 213-214, 222-223.

[21] Archives of Eleftherios Venizelos, FO 173/141, 173/142, 173/145.

[22] Stefanou, Eleftherios Venizelos, Vol. 1, 133, 222-223, Volume4, 392-422, 552-554, 688-691. K. Polychroniades, Venizelos' Opinions About the Constitutional Reformation (Athens: Papazisis, 1943) (in Greek). N. Tomadakis, (ed.), Venizelos El.: Unpublished Thoughts about the Constitutional Reformation (Athens, 1948) (in Greek); Alivizatos, Political Institutions.

[23] Sp. Marketos, How I kissed Mussolini (Athens: Vivliorama, 2006), (in Greek). Alexandros Kirtsis, Sociological Thought and Modernizing Ideas in Greek Interwar (Athens: Nisos, 1996) (in Greek). G. Mavrogordatos, The Stillborn Republic, Social coalitions and party strategies in Greece, 1922-1936 (Berkeley: University of California Press, 1983); Herring, Political Parties.

[24] Fritz Todt, "German Road – Making", Technica Chronica, 109, 1/7/1936 (in Greek). "The Olympic Block in Berlin", ibid: 111-112, 1-15/8/1936 (in Greek). Elias Gounaris, "The international Congress about Foundries in Milan" 12-27/9/1931», ibid, 4, 15/2/1932. Julius Dorpmuller, "Railways and Technical Universities", ibid, 58, 15/5/1934: 459-462 (in Greek).

[25] Technica Chronica, 77, 1/3/1935, 260.

[26] G. Theotokas, "Greece Faces the Social Question", N. Alivizatos, M. Tsapogas (eds), G. Theotokas: His Political Thought, Vol. 1 (Athens: ESTIA 1996, 1st edition 1932), 203-204 (in Greek).

[27] Jeffrey Herf, Reactionary Modernism. Technology, Culture and Politics in Weimar and 3rd Reich (Cambridge: Cambridge University Press, 1984).

[28] Michael Thad Allen, "Modernity, the Holocaust, and Machines without History", Technologies of Power, Essays in Honor of Thomas Parke Hughes, M. Thad Allen and Gabrielle Hecht, (eds.) (Cambridge, Mass: MIT Press, 2001): 175-214. Edmund N. Todd, "Engineering Politics, Technological Fundamelism, and German Power Technology", Technologies of Power, Essays in Honor of Thomas Parke Hughes, , M. Thad Allen and Gabrielle Hecht (eds.) (Cambridge, Mass: MIT Press, 2001): 145-174.

[29] Chatziiosif, Aspects of the Viability, 308-319, 154-174.

[30] Technica Chronica, no. 177, 1/5/1939, 348.

[31] Ibid, no. 179-180, 1-15/6/1939, 431.

[32] Antoniou, Greek Engineers, 361-399. See also, Panagiotis Noutsos. "Components of 4th August Ideology", N. Svoronos, H. Fleisher (ed.), Proceedings of International Congress, Greece 1936-1944, Dictatorship, German Occupation, Resistance, Athens, Educational Institution of Agricultural Bank of Greece, 1989: 59-69 (in Greek).

[33] In Metaxas' mind the State of the 4th of August constitutes or is expected to constitute a collective, organic, and soulful representation of a united society. Ioannis Metaxas, Speeches and Thoughts, Vol.1 (Athens: Govostis, 1969), 35-37 (in Greek).

[34] Metaxas, ibid: 139-140, 149-152.

[35] Metaxas perceived State as fair referee; its intervention should be founded on the necessity of restricting the strife between the different interests, and in no case on the replacement of the private initiative in the economy. Metaxas, ibid: 50-52. I. Metaxas, His Diary, Vol. 4 (Athens: Govostis, 2005), 809-812; Michalis Psalidopoulos, "Forms of Economic Thought in Greece, 1936-1940", H. Fleischer, N. Svoronos, (eds), Greece: 1936-1944, Dictatorship, Occupation, Resistance (Athens: Foundation of Agricultural Bank of Greece publications, 1989): 98-144 (in Greek).

[36] Archives of Ioannis Metaxas, FO K065/54. Psalidopoulos (ibid.) observes that during Metaxas' governance reformations were not realized in order for the Supreme Economic Council to be transformed to a Parliament of professional interests.

[37] Archives of Ioannis Metaxas, FO K065/10.

[38] I. Metaxas, His Diary, Vol. 3, 841.

[39] I. Metaxas, Speeches and Thoughts, Vol. 1, 216-217.

[40] Ibid.

[41] Ibid, 284 (speech at the swearing ceremony of the students of the University Of Athens, 20/11/1937).

[42] Metaxas I., ibid: p.144 (speech at the inauguration of the "Student's House", 21/12/1936).

[43] Metaxas I., ibid: pp.238-239 (speech to the Officials Engineers of Athens).

[44] Metaxas I., ibid: 2nd Volume, p.32 (24/2/1939).

[45] Metaxas I., ibid: 1st Volume, pp. 186-187 (speech in the dinner of the Polytechnic Club of Athens, 13/5/1937).

Transport, tourism and technology in Portugal between the late 19th and early 20th centuries[1]

By Ana Cardoso de Matos / Maria Luísa F.N. dos Santos / Maria Ana Bernardo[*]

1 – Tourism and transport: interconnected journeys

In recent years, tourism has experienced increasing interest from researchers in various areas, a fact that has resulted not only in a diversity of approaches from which this theme can be treated, but also in the uncovering of the interconnections that exist between tourism and the development of the economy of transport and of society[2].

Thus, tourist growth in each country has been the subject of several studies, ranging from economics to the political and cultural aspects associated with publicising the country as well as to the links between tourism and transport developments[3]. Research on the institutions promoting tourism and the magazines in which it is advertised has led to an understanding of the role that professionals such as engineers have played in promoting the activity and how they have long regarded it as a form of development for the economy[4] and for transport[5]. The study of travel guides is another possible approach to understanding the links between tourism and transport. Utilitarian in their nature, travel guides are a reflection of the economic, social, cultural and technological changes that, over time, have been introduced into travel for cultural purposes or for summer vacations, and which gradually have come to be participated in by

[1] The first version of this paper was presented at the Fourth Annual Conference of the International Association for the History of Transport, Traffic & Mobility (T2M), Paris 28 September to 1 October 2006.

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[2] In 2001, the International Commission for the History of Travel and Tourism was created http://www.ichtt.org/public/ichtt/bureau.htm. The communications presented at the XIII Economic History Congress, Buenos Aires 2002, analyse tourism under various headings: the infrastructures related to tourism; the actions of government and public authorities in promoting tourism; the role of the tourism industry in the economy; and the representations of tourism in relation to public opinion. These communications were published in TISSOT (2003).

[3] Vergeade-Williot, Marie-Suzanne - Le tourisme ferroviaire ou le temps impose www.eh.net/XIIICongress/cd/papers/4Vergeade-Williot276.pdf. For the links between transport and tourism see also Mom (2003: 131–132).

[4] See, for instance, Pellejero Martinez (2005: 87–114).

[5] These links have become clear from research undertaken by CIDEHUS.

increasingly larger social groups[6]. The analysis of various tourist guides allows for an approach to various themes, particularly the different forms of transport and the new industries that technological and industrial development have made available for travellers/tourists.

Analysing the 20th century tourism phenomenon thereby implies understanding all the economic, social, political and technological changes that were initiated in the second half of the 18th century and which eventually brought about today's phenomenon of 'mass tourism'. Access to tourist travel – for improving knowledge, for leisure or even for therapeutic reasons – at the beginning of the 18th century, a privilege of the aristocracy, was gradually extended to include the rich bourgeoisie. Throughout the 19th century, it embraced even wider social strata through the development of transport and communications. However, in the 20th century its high level of growth allowed tourism to become, for many regions and even for some countries, one of the main sources of income and an important support for the economy.[7] Throughout the 20th century, new achievements were established in the world of work, such as the right to paid holidays, which contributed largely to increase the numbers of those who could spend their leisure time getting to know other places and other cultures.

Many of the changes that occurred in tourism were determined by the technological and industrial innovations that generated an increase in and a broadening of new means of transport. As Catherine Bertho Lavenir observes, "les voyages changent comme changent les techniques" (Lavenir 1999: 9). According to this author, today's characteristics of tourism are the result of an evolution marked by three distinct moments, separated by technological changes. The first period was the age of coaches and railways. Shortly before the turn of the century, the bicycle and the automobile changed the travelling conditions, allowing travellers a greater mobility and freeing them from the pre-defined routes offered by the railways. In the middle of the 20th century, the expansion of road transport as well as the development of maritime transport and the increase in air transport allowed tourism travel to be undertaken by an even broader spectrum of the population (Lavenir 1999: 9–11).

This text seeks to examine the links that, from the late 19th century into the early decades of the 20th, were established in Portugal between tourism and transport, connecting them with the strategies followed by railway companies, cycling associations, the Automobile Club of Portugal (1903) and Sociedade de Propaganda de Portugal (1906) in the promotion of tourism travel within Portugal and abroad.

[6] For various approaches to travel guides, see Chabaud et al. (2000).

[7] For the history of tourism, see Boyer (1999, 2000).

2 – New forms of travel: technology, mobility and tourism

2.1 – The train: new possibilities for moving within a territory

The opening of the first section of the railway line linking Lisbon to Carregado dates from 1856, but it was only in 1863 that the whole of this line connecting Lisbon to the frontier was completed. Meanwhile, some sections of the northern line were constructed. In 1868, the direct service between Lisbon and Madrid for first class passengers was inaugurated as well as the railway service between Lisbon and Vigo.

Despite technical and financial difficulties[8] in setting up a railway network in the following years, new branches were open throughout the country, even though sparse and serving only the principal urban centres. By the end of 1907, there were 2,388 kilometres of broad gauge and 365 kilometres of narrow gauge railway[9].

This fact did not stop the railway network changing significantly the mobility of the population inside the country. On the one hand, this was because this new means of transport allowed greater distances to be covered in a shorter period of time, thereby altering the notion of space and time. On the other hand, it was because it imposed new rules for travelling – trains had established routes to follow whose times of departure and arrival could not be changed.

However, the population that did not live near the railway stations continued to face the problem of accessing them, a difficulty only wholly resolved by the introduction of the automobile.

Because the construction of railway lines required high levels of capital investment, one of the concerns of the companies that developed and exploited this means of transport was to obtain the economies of scale that would allow a return on the capital invested. To achieve this purpose the more intense utilisation and diversification of the system was necessary and, therefore, especially in the decade 1880–90, those companies implemented a series of commercial strategies to attract new consumers, namely those travelling for pleasure or for summer vacations.

With this objective in mind travel guides were published, special tariffs were put into effect, particularly during the 'sea bathing' season, and trips were organised at the time of special events such as exhibitions, congresses and fairs or to destinations whose beauty or monuments were likely to attract tourists.

[8] This required recourse to foreign technical assistance and foreign capital. On this subject, see Pinheiro (1986).

[9] J. Fernando de Sousa. Caminhos de ferro. In Notas sobre Portugal, vol. I. Lisboa: Imprensa Nacional, 1908, 764.

In 1874, when the beach at Espinho was already being frequented by a significant number of people during the summer months, the government approved by the decree of 4th May 1874 a reduction of 20% in the price of day-return tickets between the stations of Espinho and those of Coimbra and Vila Nova de Gaia, a proposal that had been submitted to the government for approval by C[a] Real dos Caminhos de Ferro Portugueses.

This type of initiative aimed at a more intensive use of first and second class carriages, which had a lower rate of utilisation. In Portugal, between 1877 and 1904, the figures for the use of the three classes of carriages, of which the trains were composed, support this fact: first class passengers comprised between 5% and 8%, second class passengers between 18% and 20% and third class passengers between 72% and 77%. Thus, the railway companies' proposals were clearly targeted towards people who had substantial economic resources and could afford train excursions or leisure outings to beaches or to bathhouses during the summer.

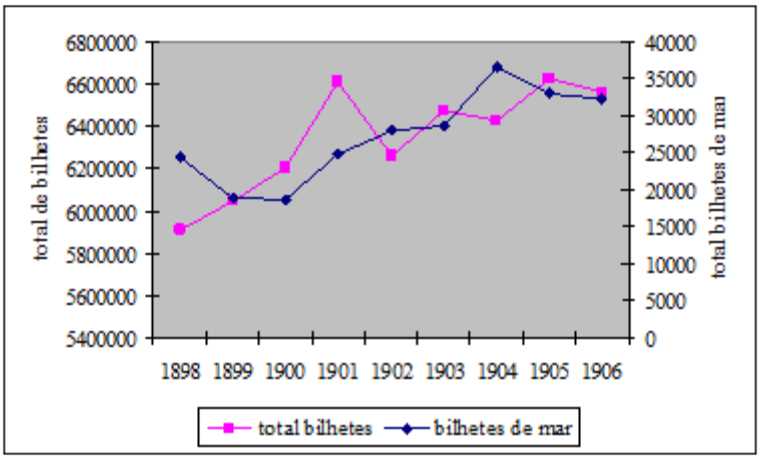
As in European countries, the guides, which assumed a practical character and provided a range of information about means of transport, hotels to stay in and places to visit, appeared in the first decades of the 19th century, linked to the development of the railways[10]. In Portugal, some of the initiatives undertaken in publishing guides were also associated with the railways. That was the case of Guia Oficial dos Caminhos-de-ferro de Portugal, published in 1882, which, as indicated on its cover, was 'the only fortnightly publication approved and subsidised by the railway board of directors and the companies'. To reach a wider range of the public this guide was sold at all railway stations.

With a view to taking advantage of the growing interest in beaches, in 1874 Companhia Real de Caminhos de Ferro submitted for government approval a reduced tariff for day-return tickets between the beach at Espinho and the cities of Coimbra and Vila de Gaia[11]. From the beginning of the 20th century, the number of tickets for beach-bound journeys showed an upward trend, even though it corresponded to only a small percentage of all tickets sold.

Tickets for the seaside sold by the Companhia Real dos Caminhos-de-ferro Portugueses between 1898 and 1900

[10] Catherine Bertho Lavenir considers that, in the history of guides, which represent a genre close to the travel narratives to which they are orientated, it is possible to establish three generations of work. The first, whose prototype is the Guide du voyager en Suisse, published by the Englishman Johan Ebel in 1793, is still very close to being a travel narrative. In the second generation, linked to the development of the railways and coinciding with the industrialisation of tourism, the guides assume a more practical aspect and include information on the monuments and the material aspects of the journey, although they are often preceded by a general introduction about the country or the region they are covering. At the turn of the century, there emerged another type of guide – monographs dedicated to a determined region (Lavenir, 1999: 58–62).

[11] This measure was approved by the decree of 4th May 1874, which reduced the price of these tickets by 20%.



Source: Reports of the Companhia Real dos Caminhos-de-ferro Portugueses, 1898–1900

Reduced tariffs were also applied to excursion groups or college and teacher groups[12]. Lower prices were applicable to periods when there were major exhibitions in Portugal or abroad with special trips being organised to see those events. For example, the Universal Exposition in Paris, which aroused great interest in Portuguese society, was the justification for organising railway excursions to that city. The excursion 'Paris for £5'[13] covered a return journey to Paris on set days, which allowed the traveller to remain in the city for 12 days to visit the exhibition, and for its organisation Companhia Real dos Caminhos-de-ferro Portugueses entered into an agreement with its Spanish and French counterparts[14].

As an incentive to encourage travelling, from the 1880s onwards there emerged the idea of roundtrips in Portugal and abroad, particularly in Spain and France. The latter resulted in a combined service between Companhia Real dos Caminhos-de-ferro Portugueses and various Spanish and French companies[15], which was widely advertised in various publications, such as Guia Portátil do Viajante em Portugal e itenerarios das viagens circulatórias em Hespanha e França, published in 1886.[16]

In 1906, the railway companies submitted a new type of ticket – 'kilometre tickets' – through which the customer paid for the kilometres travelled, no matter the destination of their journey. The advertisement for this ticket mentioned the fact that it "gives the passenger absolute freedom, allowing its use in any direction, without any obligation to follow a

[12] Concerning the various types of tariffs that were used by the Companhia de Caminho-de-ferro Portugueses, see Ribeiro (2006).

[13] Gazeta dos Caminhos de Ferro de Portugal e Hespanha, 2nd year, nº 33, 21st June 1889, p. 133.

[14] Gazeta dos Caminhos de Ferro de Portugal e Hespanha, 2nd year, nº 34, 1st July 1889, p. 150.

[15] Cf. Ribeiro (2006).

[16] Guia Portátil do Viajante em Portugal e itenerarios das viagens circulatórias em Hespanha e França. 2nd ed., Porto: Tip. Occidental, 1886.

determined itinerary"[17]. With the introduction of the kilometre tickets passengers were no longer restricted to previously defined itineraries, thereby being free to change them whenever they so wished.

2.2 – The automobile: from 'pioneers' to 'vintages'[18]

The introduction of the first automobile in Portugal dates from 1895, a time when count Jorge de Avilez bought a Panhar et Levassor in Paris, which he used for several journeys in Portugal at a speed of 15 kph. The following year, Dr. Eduardo Tavares de Melo from Coimbra imported a Peugeot from France, described by the press at the time as an "elegant car with seats for three people, … fuelled by petrol (nafta), … on hills reaches a speed of 11 kilometres per hour and on the flat 26 easy to stop, even when rolling at top speed"[19].

In 1900, there were 13 automobiles in Portugal, a number that rose in the following years.

Importation of automobiles into Portugal

Year	No. of automobiles
1900	13
1901	20
1902	51
1903	118
1904	109
1905	160
1906	175

Source: (Rodrigues 1988).

Since they were a new type of product, which was initially directed towards a clientele of pioneers with high incomes, automobiles were owned by an elite who saw this form of transport as a means of diversion, its use being closely connected with excursions and races. Only at a

[17] Gazeta dos Caminhos de Ferro, nº 436, 16th February 1906, p. 62.

[18] It was agreed, in an accord with the Federação Internacional de Veículos Antigos (FIVA; in Portugal represented by the Clube Português de Automóveis Antigos, CPAA) that there would be the following categories of classic cars: 'pioneers', automobiles constructed up to 1904; 'veterans', between 1905 and 1918; 'vintage', between 1919 and 1930; 'post-vintage', between 1931 and 1945; and 'post-war', between 1946 and 1960.

[19] O Occidente. Ano 20, vol, XX, nº 655, 10th March 1897, p. 51.

later stage did sales extend to broader groups, and innovations in this vehicle were aimed at satisfying the needs of these consumers (Caron 1997: 67). As in other countries, receptivity to motoring in Portugal was also associated with an ideal of a sporting and adventurous lifestyle.

On 27th October 1902, the first automobile race on the Iberian Peninsula between Figueira da Foz and Lisbon[20] took place. In light of the success of this initiative, in which nine automobiles and five motorcycles participated, it was planned to extend as far as Lisbon the Paris–Madrid race that was due to be held in France in 1903.

This race was the determining factor in the establishment of the Real Automóvel Clube de Portugal, an organisation that played an important role in the development of car travel in Portugal.

In the following years, automobile excursions won an increasing number of supporters and the distances raced increased significantly. In 1912, the magazine Ilustração Portuguesa stated: "Motoring is developing. There are people who go on trips that last for months, undertake extensive travels through other countries, people like the sportsman Joaquim Lory, who recently returned from the Côte d'Azure"[21]. Guides were published with the aim of encouraging and facilitating car travel. The first guide aimed at motorists Guia das Estradas de Portugal – by Elysio Mendes, one of the first Portuguese motorists – was published in 1906. Not only did it give indications of the distances between various points in the country depending on the itineraries, but it also provided information about automobile repairs or interesting sights and monuments to be visited, being considered at the time a book which "all excursion makers would have an interest in consulting".[22]

The growing interest in the automobile prompted the appearance in Portugal of various representatives of the principal carmakers, which were present at the I Salão Automóvel do Porto held in June 1914 at the Palácio de Cristal[23]. This exhibition, in which all the stands offered the services of engineers or representatives of the various makes turned out to be not only "an exhibition of foreign engineering but also an excellent showcase for national industries,

[20] Concerning this race, see O Tiro Civil. Revista de Educação Physica e de Sport Nacional, 1st November 1902 and 'O automobilismo em Portugal' in Gazeta dos Caminhos de Ferro, 1st November 1902, pp. 321–323.

[21] 'Acidentadas excursões d' Automóvel' in Ilustração Portuguesa. 2nd series, vol. 1, nº 319, 1912; p. 420.

[22] Gazeta dos Caminhos de Ferro, nº 433, 1st January 1906, p. 10.

[23] The idea of organising the I Salão Automóvel originated from a race that took place the previous year – the II Circuito do Minho – which ended with an exhibition in the central nave of the Palácio de Cristal. In this exhibition were the automobiles, motorcycles and bicycles that had participated in the race.

especially regarding the construction of the bodywork which is as good as any and particularly outstanding in terms of comfort"[24].

In 1901, after having studied the automobile industry abroad, Alfredo de Brito set up a business with the Cannells of Casa Parry & Son, Henrique Taveira, Jacintho d'Almeida and Carlos Alves. On 16th July of that year, the company launched five 'mylord' two-seater cars using a modified two-cylinder Mors motor, which reached three speeds (10, 20 and 30 km per hour)[25].

The construction of bodywork in Portugal, an industry whose origins date from 1903, was considered at the time "a new industry with a bright future, as long as the end-product was perfect and at least likely to equal what came from abroad"[26]. One of its principal promoters was the French engineer Albert Beauvalet, the representative of Peugeot, hired in 1899 by Empresa Industrial Portuguesa to supervise the preparatory work aiming at the development of a model for a national car.

In some cases, the old houses that had built horse-drawn carriages adapted their production to the components for automobiles, as was the case of the Oficina de Carruagens under the direction of Eduardo Romualdo de Vasconcelos, located in Oporto, which began producing bodies, springs and wheels around 1908 or 1909.

In requiring the use of trunks, special goggles, gloves and other specific equipment and accessories, car journeys stimulated, although indirectly, the market for the consumption of products connected with those items. The success achieved by the house of Hermes throughout the 20th century was based on brothers Adolph and Émile-Maurice Hermes's capacity to adapt to the requirements of new forms of travel, having engaged in the manufacture of products used by those travelling by car, by boat or by plane[27]. In Portugal, the company Panhard Palace, owned by Ricardo O'Neill & Co, sold cars of the makes it represented as well as 'accessories, suits for car drivers, capes and veils for ladies', that is, essential equipment for anyone travelling regularly on country roads.

The builders of automobile components were themselves involved in creating travel guides as a strategy for the promotion of their products. The publication of tourist guides by the

[24] Article in the Diário de Notícias, cited by Rodrigues (1988: 38).

[25] Gazeta dos Caminhos de Ferro, nº 326, 16th July 1901, p. 218

[26] Ilustração Portuguesa, 2nd series, vol. 1, nº 319, 1912, p.

[27] The house of Hermes has its origin in a factory founded in 1837 by Thierry, whose sons later associated themselves with the brothers Adolph and Émile-Maurice Hermes. The company underwent great development, since it knew how to 'réussir la transition de la civilisation du cheval à celle de l'automobile et s'engager dans la fabrication d'articles destinés à un nouveau genre de voyageurs' (Bergeron, 1998: 120).

Michelin brothers-owned company, which produced rubber articles, namely tyres, was thought of as an initiative for the promotion of their industrial pneumatic goods[28].

In Portugal, automobile-related companies also published maps and guides. In 1905, the Colonial Oil Company issued an automobile map, and in 1906 A. V. Patterson, its director, put out Guia Automobilístico, containing alphabetically ordered information about all of the cities and towns that could be visited on car journeys as well as an indication of the various hotels and blacksmiths' workshops that existed in each area, together with the company's petrol selling venues[29].

The diffusion of the automobile was encouraged by the press[30]. The growing interest of the Portuguese in motoring gave rise to various publications on the theme, as was the case with O Automobilista. Semanário destinado a pugnar pelo desenvolvimento do automobilismo em Portugal, whose publication began in 1910. The first issue acknowledges, "The great tourist journeys undertaken by our motorists, even when not completed, were nevertheless full of annoyances of every kind. The car axles and the chassis suffered damage because of the bad conditions of the roads. The delicate constitutions of the ladies could not bear the disagreeable bouncing around of the vehicles"[31].

News about the technological development of automobiles became increasingly regular in the publications that focused on other means of transport. For instance, in Gazeta dos Caminhos de Ferro (Railway Gazette), news about motoring became a regular item from late 19th century onwards, and in 1908 the journal introduced a section about it, changing its name to become Gazeta dos Caminhos de Ferro. Electricidade e Automobilismo. However, under the charge of Ricardo O'Neill, an engineer who, as mentioned before, was the owner of a company connected to this sector – Panhard Palace – the section only lasted two years.

The use of the automobile forced speed limits to be introduced, signposts to be erected and rules to be established among the various users of this new means of communication (Lavenir 1999: 187).

The technological innovations of automobiles, which enabled a progressive increase in the speed that could be reached, made it necessary to impose speed limits[32]. In Portugal, the

[28] Francon (2000: 114).

[29] Gazeta dos Caminhos de Ferro, nº 1906, 1st January 1906, p. 10.

[30] Journalism related to motoring began in France. There, in 1900, there were 25 publications dedicated to this theme.

[31] O Automobilista. Semanário destinado a pugnar pelo desenvolvimento do automobilismo em Portugal, 1st year, nº 4, 16th October 1910, p. 1

[32] The International Automobile Conference of 1900 established progress in relation to the automobile: from 1895 to 1898, the first automobiles attained 5 km per hour going up hills, 40 to 50 km per hour on descents and 20 km per hour on the flat. In

first regulation dates from 2nd October 1901 and established a speed limit of 10 km per hour, with heavy fines for anyone driving above it. This was not in step with the reality of the automobile, and the maximum speed was increased from 10 to 20 km per hour within built-up areas and to 30–40 km per hour on roads outside these limits.

The new form of transport also required changes in the way roads were planned and constructed since they conditioned the development of motoring tourism and for this reason their good condition became a constant concern for the societies promoting this activity.

2.3 – The automobile as complement to the train

At the end of the 19th century, railway technology was providing less and less of an answer to the new transport needs (Caron 1997: 103). Therefore, when the automobile began to be a more common feature in the country, this means of transport also came to be seen as a business to be developed and exploited, either ensuring links between places that were not yet served by the railway or between a particular place and a railway station.

At the beginning of the 20th century, there was increasing awareness in Portugal that road transport, particularly the automobile, was an important complement to the railway. To secure a road link between localities and railway stations, in 1903 the government authorised the application of a special fund for the construction of roads[33]. Despite still being a novelty, the automobile was seen as the ideal complement to the railway network. An article dating from 1901 acknowledges that:

> "The railway cannot go everywhere; to stop near all the places which spread out over the countryside it would have to weave from one to the other, prolonging the journey. Constructing small, local lines, like vertebrae from the spine, to take passengers and goods to neighbouring villages is almost always difficult and often not financially justifiable, given the small amount of traffic. Therefore, the automobile is an invaluable element!".[34]

1900, automobiles could attain 50 km per hour going up hills, 100 km per hour on descents and 70 to 80 km per hour on the flat. Cf. Studeny (1995: 312).

[33] João da Costa Couraça - 'Viação ordinária' (everyday transport) in Notas sobre Portugal. vol. I. Lisboa: Imprensa Nacional, 1908, p. 785.

[34] Gazeta dos Caminhos de Ferro, nº 332, 16th October 1901, p. 333.

This recognition of the potential importance of the automobile played a decisive role in the passing of a law on 3rd October 1901, which enforced the inspection of all automobiles and regulated speed and safety conditions in relation to the circulation of this vehicle.

Thus, from the beginning of the 20th century advertisements began to appear announcing automobile services linking various localities in the country. In 1903, it was reported that "a large motorised vehicle business has just been established in Lisbon, with the aim of providing a valuable service to several parts of the country, linking them by means of motorised vehicles for the transport of passengers and goods"[35].

In 1904, two businessmen, George Frechou and Carlos de Sousa Reis, obtained a 19-year concession for the exclusive right to transport passengers, luggage and mail bags among Santarém, Almeirim, Alpiarça and Chamusca in petrol-driven vehicles that carried a maximum load of 1,400 kg. They agreed to have personnel in all the appropriate locations to receive and deliver the bags that were driven to and from the mail trains, as well as to guarantee that the motorised transport would meet the arrival and departure of all express and mail trains (two mixed trains in the morning and another two in the afternoon). Prices would be the same as those applied by the coach companies. A similar concession was sought at the same time by two other businessmen for the Beira Alta region. The applicants intended to link several regions with railway stations in the Douro, the North and Beira Alta. The route would serve the arrival and departure of all mail and express trains, and the service would be guaranteed by petrol-driven motor vehicles travelling at an average speed of 25 km an hour[36].

At the end of 1905, a motor vehicle service between Sines and Setúbal was set up. These vehicles could accommodate 18 passengers and accompanying luggage, and they covered 110 kilometres at 18 km an hour. At that time, a similar service was introduced between Aveiro and Ílhavo using a 220-seat vehicle, and a regular service of motorised vehicles among Oliveira de Azeméis, Estarreja and Murtosa was expected to be operating in the near future[37].

The significance acquired by the automobile as a complement to and an extension of the railway was clearly stated the following year when it was announced that "as soon as the railway line from Coimbra to Lousã is opened, a motor vehicle service will also be established between Lousã, Góis and Arganil"[38].

[35] Idem, nº 363, 1st February 1903, p. 42.

[36] Idem, 1904, p. 109.

[37] Idem, nº 434, 16th January 1906, p. 26.

[38] Gazeta dos Caminhos de Ferro, nº 440, 1st April 1906, p. 126.

In 1909, engineer Mello Mattos published an article on 'Roads of the Future' in Gazeta do Caminho de Ferro because "the railway has not killed the road and that is why motoring will reinvigorate the railroad, and the war which the new is declaring on the old is perfecting what was about to lose its life"[39]. The following year, when referring to a conference given by the Italian engineer Ruggeri on roads and motoring at the headquarters of the Society of Italian Engineers and Architects, Mattos stated that "motoring is the logical and indispensable complement to the railways"[40].

As time passed, the motor vehicle became more common, which prompted this exclamation in 1912: "At last! The owners of horse-drawn coach lines are slowly realising that these detestable vehicles are out of touch with the 20th century and that they can only be replaced by the automobile", to which the following was added, "Those of us who intend to live from tourism should finish off an inconvenient means of transport"[41].

Despite this optimism, the truth was that in most parts of the country connections continued to be made by horse-drawn coaches, which was partly explained by the substantial capital required to set up an automobile business. For this reason, it was claimed that, as in the case of France and the UK[42], the railways should take on the task of setting up the necessary motor routes. Such an initiative – greatly acclaimed – was taken by the Beira-Alta Railway Company, which in 1913 inaugurated "a bus service connecting the most important places in the region served by its line to the respective railway stations"[43]. This service used four Panhard-Levassor vehicles, each having a first class and a third class compartment to transport 17 passengers and accompanying luggage.

In Portugal, the interdependent nature of the train–car relationship also worked the other way round. At the beginning of the 20th century, the state of repair of the roads frequently made people resort to the railway as a means of travelling across certain areas. In 1911, one of the main concerns of Automóvel Clube de Portugal was the fall in the price of automobiles because of the railway since "the state of repair of the roads in our country unfortunately leaves much to be desired, which frequently makes the motorist turn to the convenience of using certain railway routes"[44].

[39] Mello Matos, 'As Estradas no Futuro' in Gazeta dos Caminhos de Ferro, nº 522, 16th September 1909, p. 275.

[40] 'As estradas e o Automobilismo' in Gazeta dos Caminhos de Ferro, 23rd Year, nº 549, 1st November 1910, p. 324.

[41] Gazeta dos Caminhos de Ferro, nº 586, 16th May 1912, p. 155.

[42] In these two countries, the railways exploited this service.

[43] Gazeta dos Caminhos de Ferro, nº 615, 1st August 1913, p. 235.

[44] Annuario do Automóvel Club de Portugal, Lisboa, 1917, p. 10.

2.4 – The bicycle: the freedom of individual transport

Since the invention of the first cycling machine, constructed in 1693 by Ozanam, the bicycle met with successive technological improvements right up to the 19th century. By improving comfort for cyclists, the invention of the pneumatic tyre by Dunlop in 1889 contributed significantly to the use of the bicycle by the general public.

At the end of the 19th century, cycling had a considerable number of followers in Portugal. In 1897, there were 6,000 bicycles in the country, a number that, nonetheless, was smaller than in other countries. Represented by several Lisbon retailers, various makes were sold: Columbia and Herittford cycles were sold by Columbia; the Clement cycle by Santos Beirão e Henrique; and the Peugeot cycle by José d'Orey & Co., the only agent in the country for "the famous Peugeot bicycles, which had won most of the first prizes in Portugal". The advertisement for the Clement bicycles claimed that they were "the nobility, the clergy and the people's favourites. It cannot be otherwise, since their reputation is universal and no other bicycle matched them in elegance, perfection, lightness, smoothness of movement and prices"[45].

Among the reasons given for the slow development of cycling in Portugal was the cost of bicycles in the country. But also mentioned were "the rough nature of our land and the appalling state of our roads, which weaken any aspirations or inclinations we may have towards the development of cycling, since they make it awkward and hard for the beginner or the less physically fit to go on the kind of long excursions which are the real and main delight of the bicycle"[46].

3 – The promotion of tourism and new methods of transport by the 'Touring Clubs'

The Touring Clubs, initially connected with cycling, had as their model the English Cyclist Touring Club, which had been organising group excursions since 1875 and whose membership amounted to 25,000 associates in 1879. This organisation's influence spread to the countries of continental Europe. In 1890, the Touring Club of France was set up and its headquarters were situated in one of the avenues leading to the Bois du Boulogne, a favourite place among cyclists. In 1896, this society had 40,000 members and had diversified its activities. The appearance of the first automobile in the country in 1895 and its later spread brought about the publication of technical texts about this new means of transport as well as concern about the state of the roads,

[45] Idem.

[46] O Sport 'Velo': revista velocipedica (cycling magazine). Year 1, nº 1, 14th January 1897, p. 3.

which now had new users[47]. Meanwhile, there was an attempt to extend tourism to all the regions of France as well as create the concept of "tourism regions" and identify certain cities as "centres of tourism" (Young 2002: 172). By contrast, their activity was extended to the modernisation of hotels and the protection of historic monuments, prompting the establishment of a professional association and the publication: Sites et Monuments. With this initiative the Touring Club of France "prend en charge des actions d'intérêt collectif qui ne font pas encore explicitement partie des fonctions de l'État"[48].

3.1 – The Portuguese 'Touring Clubs'

3.1.1 – The União Velocipédia Portuguesa

As a result of the interest that cycling aroused in Portugal, various connected associations were established at the end of the 19th century[49]; Club Velocipedista de Portugal (Portuguese Cycling Club) was set up in Lisbon in 1891, Velo Club in Oporto in 1893 (later named Real (Royal) Velo Club) and the Velo Club de Lisboa, a new association created in Lisbon in 1894. In the following years, new associations sprang up all over the country because "the number of cycling enthusiasts increased astonishingly"[50].

With a view to bringing together the various existing associations – and following the pattern of its counterpart, the French Cycling Union – União Velocipédica de Portugal was established on 14th December 1899 with the following stated objective: to develop cycling and make it more widespread in all its forms and applications"[51]. Shortly afterwards this association became an affiliate of the International Cycling Union.

Although cycle racing was its main activity, União Velocipédica de Portugal also organised excursions and sought ways of promoting tourism by bicycle. Thus, in 1900 it demanded that the government "allow free entry to the bicycles of tourists who visit our country, as successfully happens in France, in Belgium, and even in Spain"[52].

[47] Concerning the Touring Club of France, see Lavenir (1999: 96 et seq.).

[48] Idem, 98.

[49] Especially from 1880 onwards, numerous cycling associations were established in most European countries. Concerning France, see Thompson (2002: 136).

[50] União Velocipedica Portugueza - Relatório e Contas: gerência de 19 de Julho de 1900 a 31 de Dezembro de 1901, Lisboa, 1902, p. 6.

[51] Idem, 1913, p. 3.

[52] Idem, 1901, Lisboa, 1902, p. 47.

According to a report of the directorate of this union, at the beginning of the 20th century "cycling as a sport is going through a serious crisis because of the astonishing development of motoring, which is now the chosen sport of the rich and the privileged"[53].

Nevertheless, cycling was gradually appearing as the subject of various articles in magazines and newspapers. In 1900, the magazine Occidente published a didactic article on the best way to use a bicycle, namely focusing on the dangers and potential accidents for the tourist on the road[54]. At the same time, the Portuguese Cycling Union continued to develop activities intended to promote the practice of cycling by setting up signposts on various roads in 1906, an initiative which was considered "an extremely relevant service for excursion makers"[55].

3.1.2 – O Real Automóvel Clube de Portugal

The Royal Automobile Club of Portugal, founded, as mentioned above, in 1903[56], played an important role in developing automobile transport in Portugal. Shortly after it was set up, the Portuguese club made contact with the Automobile Club of France[57], "the most important of all, not only because of the part France had always had in the automobile industry but also because of its unrivalled organisation, which gave it a hegemony among the great European clubs"[58].

Recognition of Real Automóvel Clube de Portugal by its French counterpart allowed it to be represented by delegates at the international congresses that met in Paris for the Salons de L'Automobile, du Cycle et des Sports, at the tourism congresses and at other international meetings with an interest in motoring. Affiliated to the International Association of Recognised Automobile Clubs, the representatives of the Portuguese Automobile Club took part in its congresses and, in 1907, when the Commission for International Sport was created Portugal was represented by a delegate.

As well as organising various motoring competitions, this association also ran tourist excursions. In 1907, when an automobile exhibition took place in the Spanish capital, the

[53] Idem, 49.

[54] O Occidente. Year 23, vol. XXIII, nº 782, 20th September 1900, p. 210.

[55] Boletim da Sociedade de Propaganda de Portugal, nº 2, 1906, p. 15.

[56] The Statutes of the Royal Automobile Club of Portugal were formally approved by the Geographic Society on 15th April 1903. King Carlos, an aficionado of motoring, accepted the honorary presidency of this club and Prince Afonso the role of effective president of the board of the general assembly. The presidency of the directorate was entrusted to Carlos Roma do Bocage. Cf. (Silva and Ribeiro, 1990: 16–17).

[57] The Automobile Club of France was created in 1895 by Henry Duecthe de La Meurthe.

[58] Annuario do Automóvel Club de Portugal, Lisboa, 1917, p. 5.

association attempted to organise an excursion competition between Lisbon and Madrid, but the initiative did not succeed because the Royal Automobile Club of Spain failed to support it.

While promoting the use of the automobile, this club played an important part in drawing the government to alter the decrees that regulated the circulation of automobiles. Because of its influence, the legislation of 1901 was altered by the decrees of 27th March 1909 and 27th May 1911, the former reducing the number of fines and permitting an increase in speed from 10 to 20 km per hour in built-up areas and from 30 to 40 km per hour on the open roads as well as making car registration compulsory. These decrees also recognised Automóvel Clube de Portugal as an official entity, thereby giving it the necessary financial means to launch the demarcation of roads in accordance with the international convention. It also set up regional offices for the North, the South, the Azores and Madeira, where car and driver inspections conducted by representatives of Automóvel Clube de Portugal took place.

Despite the development of activities that this association was involved in and the help that it provided for its members, only a small number of motorists became members: out of the existing 3,936 motorists in 1907, only 422 were members of the Automóvel Clube de Portugal.

3.1.3 – Sociedade de Propaganda de Portugal[59]

The founding of Sociedade de Propaganda de Portugal, also known as the Touring Club of Portugal, dates from 28th February 1906. Its objectives were "to promote on its own, by joint intervention with public authorities and local administrations, by collaboration with them and with all of the active forces within the nation and by the international relations it may establish, the intellectual, moral and material development of the country and principally to encourage both the Portuguese and foreigners to visit it and love it"[60].

By December 1906, the number of members had risen to 2,175 (1,054 founding members and 1,121 new members), a trend that was consistent in the following years. Since the membership of the Portuguese Association compared with that offered by other European touring clubs, this meant it was significant in relation to the size of Portugal. Among the various commissions created within Sociedade de Propaganda de Portugal were those for the land and maritime systems of transport, which illustrates this society's concern for the development of communication routes.

[59] For the Sociedade Propaganda de Portugal, see Matos and Santos (2004).

[60] Estatutos da Sociedade de Propaganda de Portugal. Lisboa, 1906.

The interest of the railway companies in the organisation of a society likely to promote the development of tourism in Portugal was demonstrated by the participation that the directors of these companies had in Sociedade de Propaganda de Portugal. In 1906, engineer André Leproux, the director of Companhia Real dos Caminhos-de-ferro, was appointed vice president and António Carrasco Bossa, another engineer in the same company, was chosen as a voting member of the directorate.

The interconnection between the various forms of transport, particularly between the ships arriving at the port of Lisbon and the railways, was a matter of concern. Having this objective in view, from 1906 onwards it sought to establish a Sud-Express train that would leave Lisbon on Thursdays following the arrival of the ocean liners from America. Because of the society's painstaking efforts, this train, named the Sud-America-Express[61], began to operate on 21st June that same year.

4 – Final remarks

The development of tourism was greatly facilitated by the development of land, sea and air transport as well as communication routes. Similar to what was happening in other European countries between the late 19th century and the early 20th century, Portugal also witnessed the launching of several initiatives to stimulate and facilitate the mobility of peoples and goods, thereby contributing to the promotion and development of tourist activities. The companies connected with the transport systems, such as the Companhia Real dos Caminhos de Ferro Portugueses (Royal Company of the Portuguese Railroads), developed strategies to increase the number of passengers in the several regions covered by their networks. This development was crucial for the progressive enlargement of tourism, whether by the adoption of a more favourable pricing policy during the season of 'sea bathing' – which allowed an increase in the number of first and second class passengers – or by the expansion of the railroad network to cover the main cities of the country and to serve some areas visited mainly during the summer or thermal epoch (e.g. Figueira da Foz or Curia). Equally relevant was its role in the impetus given to the automobile transport to connect the railroad stations to the towns that they served, or the attempt of easing off itineraries for the several lines by creating kilometric tickets as an alternative to ordinary tickets. Other companies connected with the automobile transport and oil, such as the Colonial Oil Company – at a time when the automobile was still in Portugal a means of transportation only used by certain elites – sought to promote and facilitate its use by

[61] Boletim da Sociedade de Propaganda de Portugal, nº 1, July 1907, p. 12.

publishing roadmaps and guides that served two purposes: to inform and to advertise. The organisations with an associative nature stemming from the civil society – among which were the Portuguese Cycling Union, the Royal Automobile Club of Portugal and the Propaganda Society of Portugal – were fundamental in the development of tourism and its related activities. They sometimes even assumed an almost official character, both through developments in the governmental sphere and the acknowledgement they expressed. In addition to calling attention to the most important aspects of a developing activity, their initiatives, together with the information, ideas and opinions put forward by their members, often worked as an alert for the resolution of problematic situations, for example the condition of the roads, which was a serious hindrance both to cycling excursions and the development of tourism based on road mobility. Complementarity between the various means of transport was soon considered crucial to the smooth circulation, not only within the country but also in the establishment of connections between countries and continents through land and sea routes. With this target in mind, the Tourism Office, established in May 1911 as the first Portuguese institution dedicated to tourist activity, stated that "it is also due to the shortening of the journey that the French think of using our country as a go-through zone to Morocco", thereby claiming that "Portugal is the natural bridge that will serve other countries in their international relationships"[62].

[62] Report of the Serviços da Repartição de Turismo (I), September 1911 to June 1912, pp. 29 and 31. Quoted by Sérgio Palma BRITO (2003: 454).

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Printing and typesetting in film

By Dr Rob Banham*

Abstract

This article demonstrates the significance of films showing the historical printing and typesetting technologies to both researchers and teachers in the field of history of graphic communication. This is an area in which there were enormous technological changes during the 20th century, many of which have never been documented in printed publications of any kind and are now entirely obsolete, leaving film as the only surviving record. It is one of the outcomes of a research project investigating films of printing and typesetting funded by the Arts & Humanities Research Council in the UK (the other is a handlist which catalogues the films themselves). The article also explains the genesis of the handlist and documents the major archives of such films.

Keywords: film, printing, typesetting, social history, archives

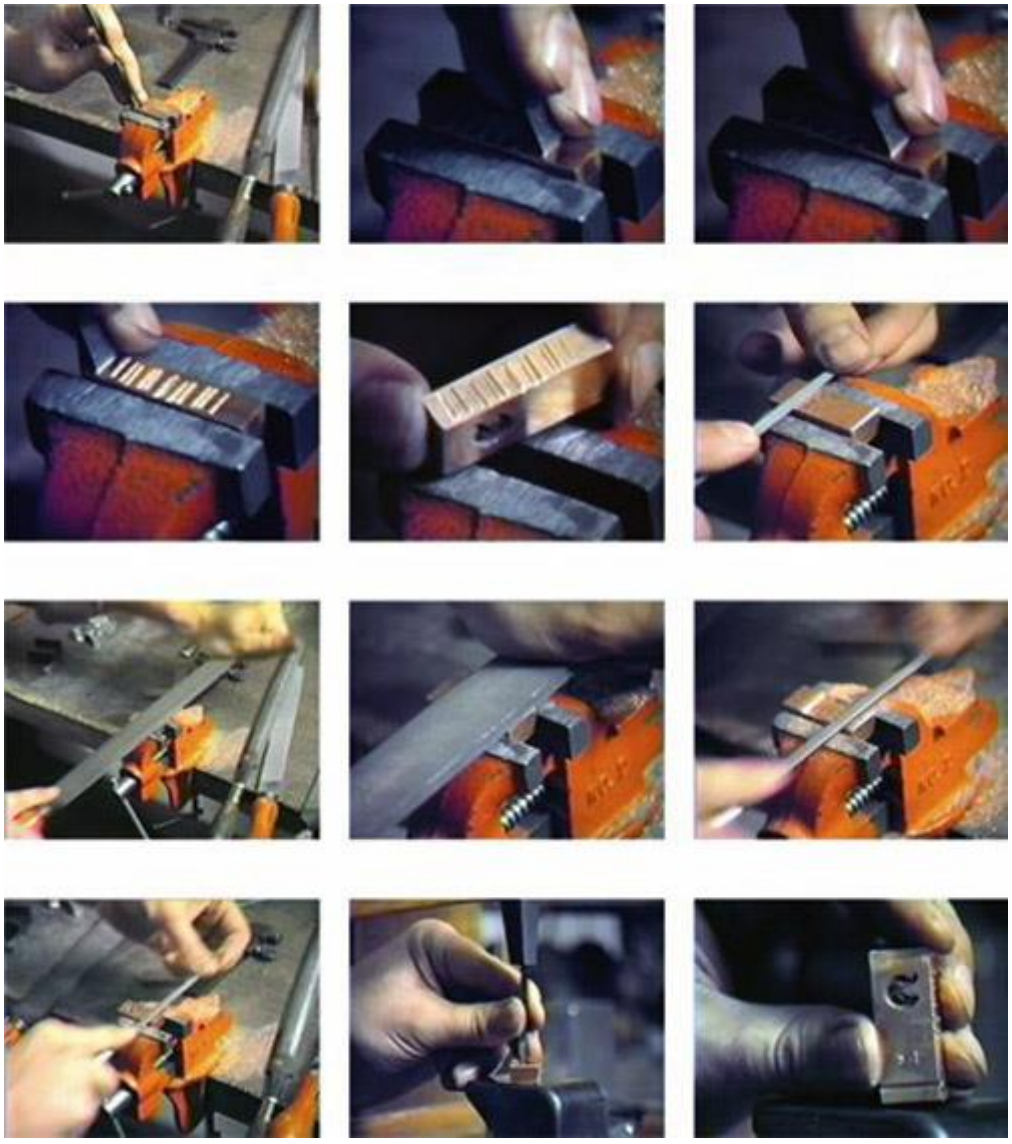
Printing and typesetting in film

In 2007 I began teaching history of graphic communication to undergraduate students in the Department of Typography & Graphic Communication at the University of Reading. This experience quickly confirmed that live demonstrations are much more effective than formal lectures when teaching students historical printing and typesetting processes. The Department is fortunate to be able to demonstrate a number of technologies to its students including hand typesetting, a Monotype keyboard and caster, hand presses (letterpress, intaglio, and lithography) and powered printing machines (letterpress and offset lithography). However, there are no facilities for casting type by hand, no Linotype or Intertype machines, no rotogravure, phototypesetting or flexography, and no material thing on related trades such as papermaking and binding. The machinery that we do have relies on specialist knowledge if we are to use it for practical demonstrations and this is not something that we can depend on having in the future – for example Mick Stocks, former head of the Department's Design & Print Unit who recently retired after 42 years of service, was the only member of staff who could run the Monotype caster.

The numerous technologies that cannot be demonstrated to students, and the likelihood that this list would grow longer in the future, led me to investigate the possibility of using film as a teaching aid – clearly the next best option when a live demonstration is not possible. I soon discovered that such films are not easy to find and so, funded by a research grant from the Arts & Humanities Research Council (AHRC), set about locating, documenting, and acquiring copies of relevant films. In total I watched almost 250 different films, which varied enormously in quality of both content and recording. Many should be avoided by all but the most dedicated researcher either because they are too specialist to be of any use to the inexpert viewer or simply because not enough detail can be seen to make viewing worthwhile. For example, three films about how to maintain the Meihle vertical letterpress machine – a total of almost three hours of footage – are so specific as to only really be of use if you want to know how to run that particular machine. However, there are many films that provide highly informative records of historical methods of printing and typesetting. In many cases these films challenge the accepted views of the technologies that they document and, when gathered together, provide an alternative view of their history. Written accounts, perhaps inevitably, present the history of printing and typesetting technology in a linear fashion whereby each new method or machine replaces its predecessor in a logical, sequential order. The films reveal a much more complex narrative in which many variant technologies are developed at around the same time and often a seemingly nonsensical mix of old and new technologies are used in conjunction with one another. Films that show the working practices of specific companies reveal that, in many cases, different firms used radically different methods to achieve the same ends. This was particularly true during the 1950s and 1960s when there were myriad ways to produce photographic plates for printing by offset lithography, often using metal type rather than phototypesetting. Most authors of works on printing and typesetting have no practical knowledge of the technology about which they are writing and in some cases this results in misleading descriptions being published. Often films demonstrate that several stages of incredibly skillful hand-finishing were required for what are generally thought of as entirely mechanical processes, or that technologies which written accounts describe in very simple terms were actually much more complex. Many of these techniques are now long forgotten, or poorly documented, but footage of processes such as preparing a forme of type for reproduction using Bright Type or applying a Benday mechanical tint to a printing plate has preserved them for posterity [1]. Potentially these films can provide historians with a new insight into printing and typesetting technology but my experience proved

that locating such films is difficult and that watching the films was frustrating because there was no means of knowing whether or not a particular film would be of any interest.

1. The art and technique of photo-engraving (c.1950) University of Reading / Rare Book School



Applying a Benday tint to a plate: 1–2 stopping out areas not to have the tint applied; 3 selecting a Benday screen; 4–6 inking the screen; 7–8 fixing the screen to the shading machine; 9–12 transferring the Benday tint onto the plate using a burnisher.

The outcome of my research is A handlist of films showing printing & typesetting which lists 240 films that include relevant footage.[1] There are a number of ways that the Handlist can be used to help direct researchers to those films that are likely to be of interest to them. It is divided into categories and subcategories based on those used to catalogue books at

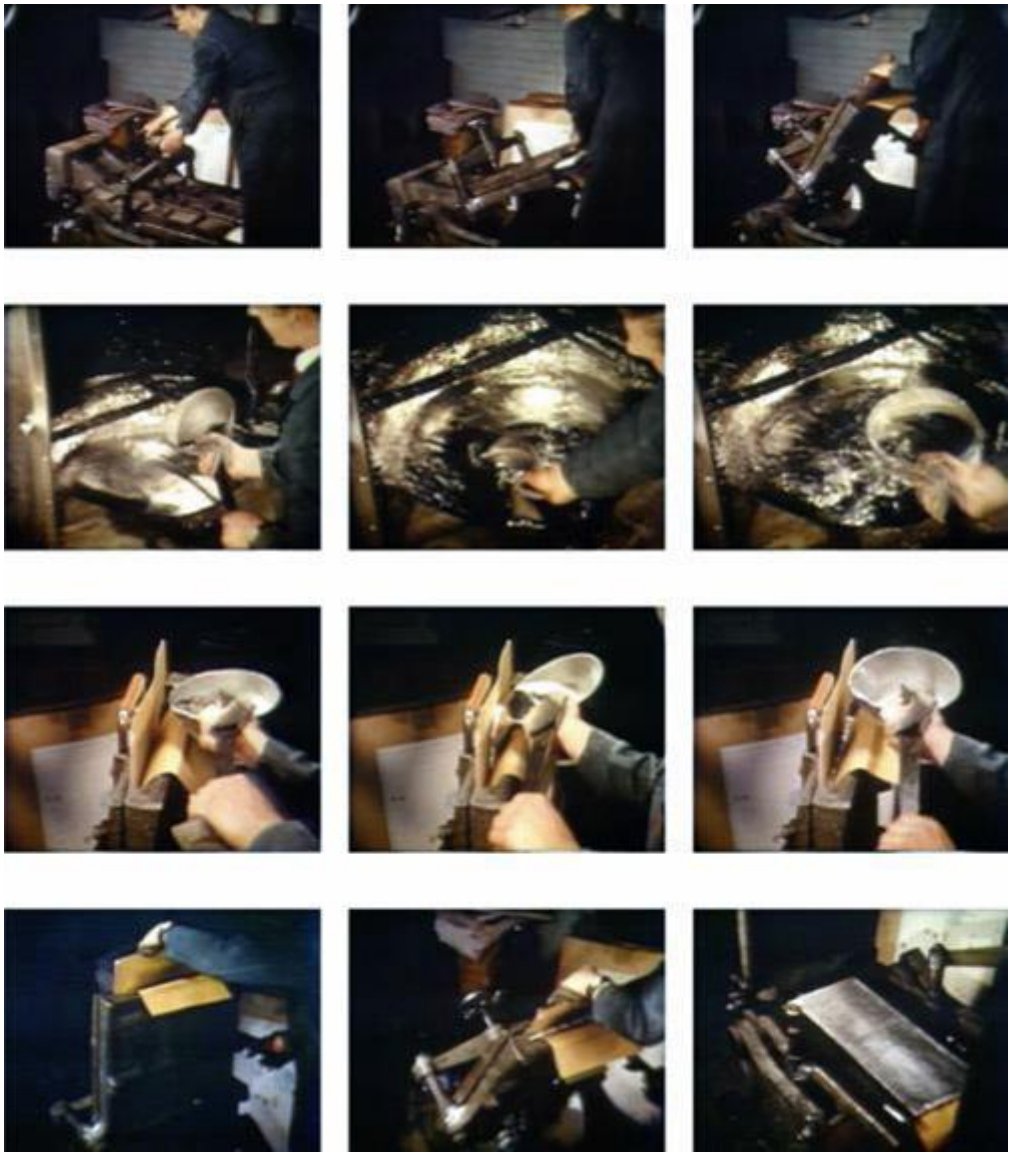
St Bride Library in London (the world's largest specialist library for printing, publishing and the graphic arts) but because many films could potentially be put into a number of different categories an index is also provided. More specific searching, or searches for technologies which may appear in several different categories, can be done electronically by searching the pdf for relevant terms. The location, date, format and length of film are also given. An overview of each film provides a short description and, for longer films, there is also a summary that provides more detailed, chronological information about what the film covers. The vast majority of films listed are in the collections at either the University of Virginia, the University of Reading or the British Film Institute, or are available online.

The 'Doc' Robert Leslie collection, Rare Book School, University of Virginia

Rare Book School has a collection of 175 films, videotapes and DVDs on graphic arts subjects and is the largest and most significant if its kind. It covers a wide range of subjects including bibliography, writing, manuscripts and letterforms, papermaking, book illustration, and bookbinding. I was fortunate to be able to visit Rare Book School to view those films that featured printing or typesetting and I am grateful to Terry Belanger and his team for their generous help and assistance. The catalogue of the collection modestly claims to be 'stubbornly full of out-of-date – and in some cases inaccurate – information' but I found it an indispensable aid to tracking down copies of many films. A small number of these are still publicly available including three useful films on lithography from the Tamarind Institute (www.unm.edu/~tamarind/) and four films can also be bought directly from the Book Arts Press (www.rarebookschool.com) including the excellent From punch to printing type. This is by far the most detailed film on punchcutting and handcasting type and is the only one to include steps such as dressing type and to show the various specialist tools and equipment required [2]. A shorter film explaining the basics is available from the University of Reading (Making type by hand). Sadly many of the most informative films in the Leslie collection are no longer available and have not yet been discovered in any other institution. These include Basic reproduction processes in the graphic arts and Printmaking processes, which are two of the only films in the Handlist to explain the basic principles of the major printing processes, and Fine lines, a film produced by the Department of Geography at the University of Edinburgh about the production of maps, which illustrates the process of printing maps from copper engravings. Fine Lines includes unique footage of making corrections to engraved plates and some

exceptional close-up shots of engraving the maps with punches and burins. However, the maps are actually printed using offset lithography; an excellent demonstration of printing copper-plates by hand is given in a recently produced film, Photogravure: an archaeological research.

2. Looking at litho (1950s?) University of Reading

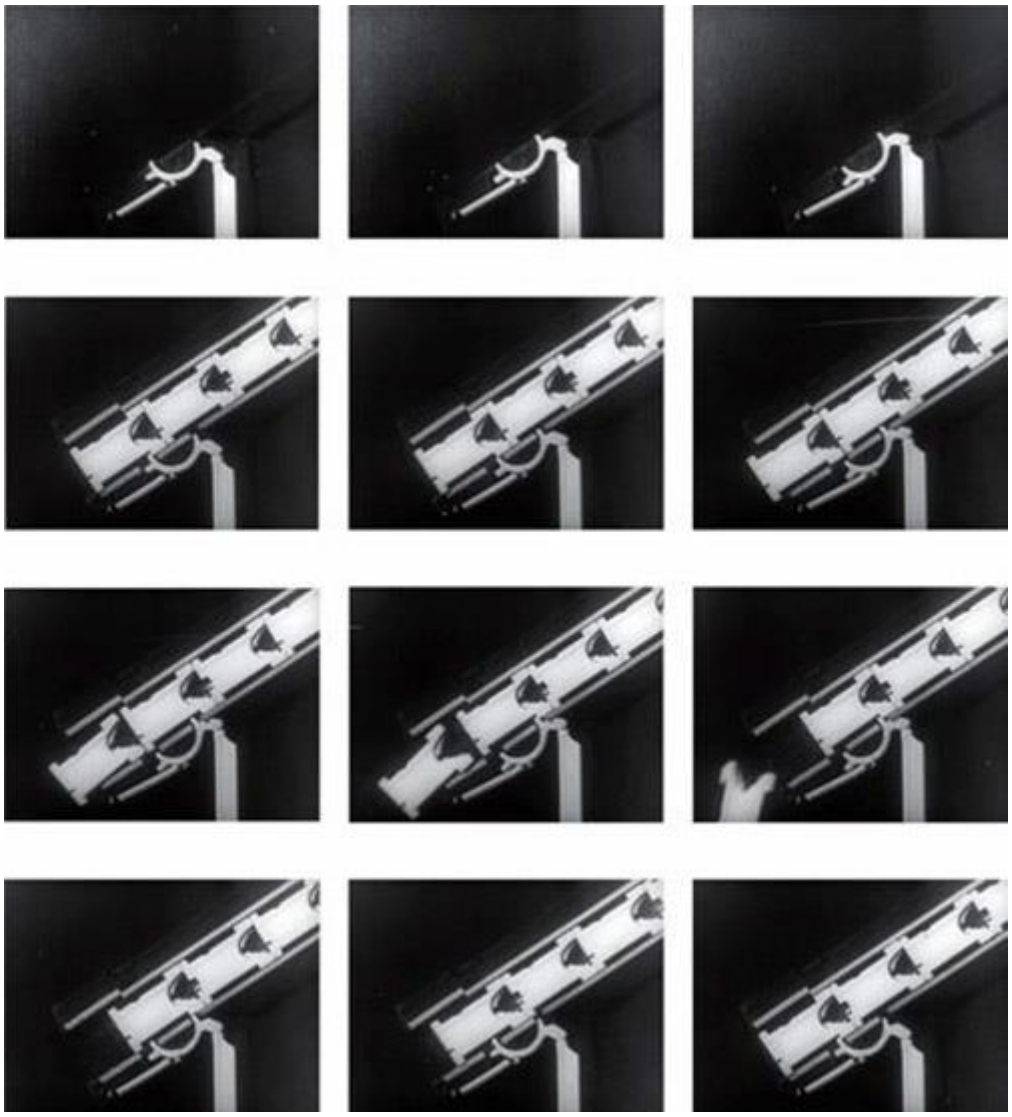


Casting a stereotype plate: 1–3 closing the casting box and moving it into a vertical position, ready for casting; 4–6 filling a ladle with molten type metal; 7–9 pouring type metal into the casting box; 10–12 the casting box is returned to a horizontal position and opened to reveal the cast metal plate.

The University of Reading

The Department of Typography & Graphic Communication had a very modest film collection before this project began but did hold a number of titles that have not yet been discovered elsewhere (including The information industry: can you manage it? starring a very young Rik Mayall and Dawn French which has to be seen to be believed). The most significant titles were the Department's own production Making type by hand and Proofing: a bridge to quality which for the most part is about as interesting as it sounds but is the only film discovered so far to include an explanation of how Cromalin proofs are made. The Department now has a collection of nearly 100 films2 and I am extremely grateful to all those who helped to build it up; particularly Carl Schlesinger, who provided copies of the many films in his collection and Michael Passmore, who donated several films including two real gems – Colour in print and Looking at litho. The former includes an excellent explanation of the process of casting stereotype printing plates [3]. This comprises just a few minutes of film but is of enormous value because written descriptions of stereotyping technology are notoriously confusing and often in conflict with one another to the extent that one wonders if the authors have actually seen the process in action. Being able to watch it happen, together with a voice over explaining every stage of the process is refreshingly illuminating.

3. Typesetting (1960) www.archive.org



Sequence demonstrating how Linotype slugs are released from the magazine when a key is pressed.

British Film Institute

Films in the BFI collection can be viewed by appointment (viewers pay by length of film). Unfortunately there is no publicly available catalogue but all 27 films featuring printing and typesetting are included in the Handlist. Almost half of these films are about newspapers and together they provide an excellent overview of local and national newspaper production in the UK during the 20th century, particularly from the 1920s to the 1960s. Major newspapers covered include the Daily Mail, The Times, the Manchester Guardian, and the Daily Herald. The other strength of BFI's holdings is the number of films produced before WW[2]. These

include Three Linotype machines (1900) which is the earliest known film of any hot-metal machine; Die Fabrication von Briefmarken (1910) filmed at Perkins & Bacon in London; Gesamtansicht der Fabrik (1911), a German film about book production; and The production of a map (1917) which shows the production of maps by offset lithography from copper-engraved originals.

Films online

There are a surprising number of films available online and obviously they have the advantage of being available to anyone with internet access and don't require a trip to London, Reading, or Charlottesville. As far as films of printing and typesetting are concerned there are two important online archives – the British Pathé News Archive and the Internet Archive.

The British Pathé News Archive (www.britishPathé.com) allows visitors to search over 3500 hours of British Pathé footage which includes over 90,000 individual items covering news, sport, social history, and entertainment from 1896 to 1970. Low quality versions of the films can be downloaded for free, higher quality versions currently cost £29.38 each, irrespective of the length of the film (most are around two minutes) or £587.50 to publish them on the web.[3] The archive includes over 80 films that show printing or typesetting. Many of these are about newspapers, often stories about the production of army newspapers during WW2, and only include brief shots of presses running. However, others have unique footage of the production of ephemeral items such as maps, globes, tickets, greetings cards, and census papers.

The Internet Archive (www.archive.org) is a US charity that was founded to build an internet library in collaboration with major institutions such as the Library of Congress and the Smithsonian. Access to the site is completely free, as are downloads of the material which currently includes over 100,000 movies. Most can be downloaded in a variety of different levels of quality with the best being good enough to view at full screen. There are over 25 films relating to printing and typesetting currently available and the list continues to grow. Two of the most interesting are Spot news, which shows how pictures were scanned and sent by telephone in 1937 – long before the advent of email attachments – and Typesetting (1960) which is a brilliant, in-depth explanation of how the Linotype machine works [4]. Unfortunately there is no equivalent film for the Monotype, the nearest is Rich Hopkins' Casting a font of metal type (1986). In theory a historian interested in the technical details of how Monotype or Linotype machines worked could consult an instruction manual but often the manuals for these machines

are so poorly written as to be almost unintelligible, particularly to someone who does not already have intimate knowledge of the machine in question. Instructions for dismantling, assembling and adjusting the Monotype casting machine, published by the Lanston Monotype Machine Company in 1918 contains no less than 437 separate instructions without the aid of a single illustration or diagram. A typical instruction reads as follows: '63. With a suitable spanner loosen the Mold-blade-conecting-rod-ball-socket Nuts 46E1, 47E1, Plate E1. Note this Connecting-rod has right hand threads. Then with the pin wrench inserted in the hole in the Mold-blade Connecting-rod 45E, Plate E1, loosen the Mold-blade-connecting-rod Lock-nuts 45E1 and 45E2, Plate E1, and run them back on the Rod as far as they will go. The Mold-blade-connecting-rod-ball-socket Plugs 46E2 and 47E2 can now be run down on the Rod, permitting the Ball Sockets to be lifted off the Ball the Cam Lever 44E and the Mold-blade Bell Crank 41E.' Needless to say, watching someone do it is far more instructive.

4. Two millions a day: a tram ticket tale (1920s?) www.britishpathe.com

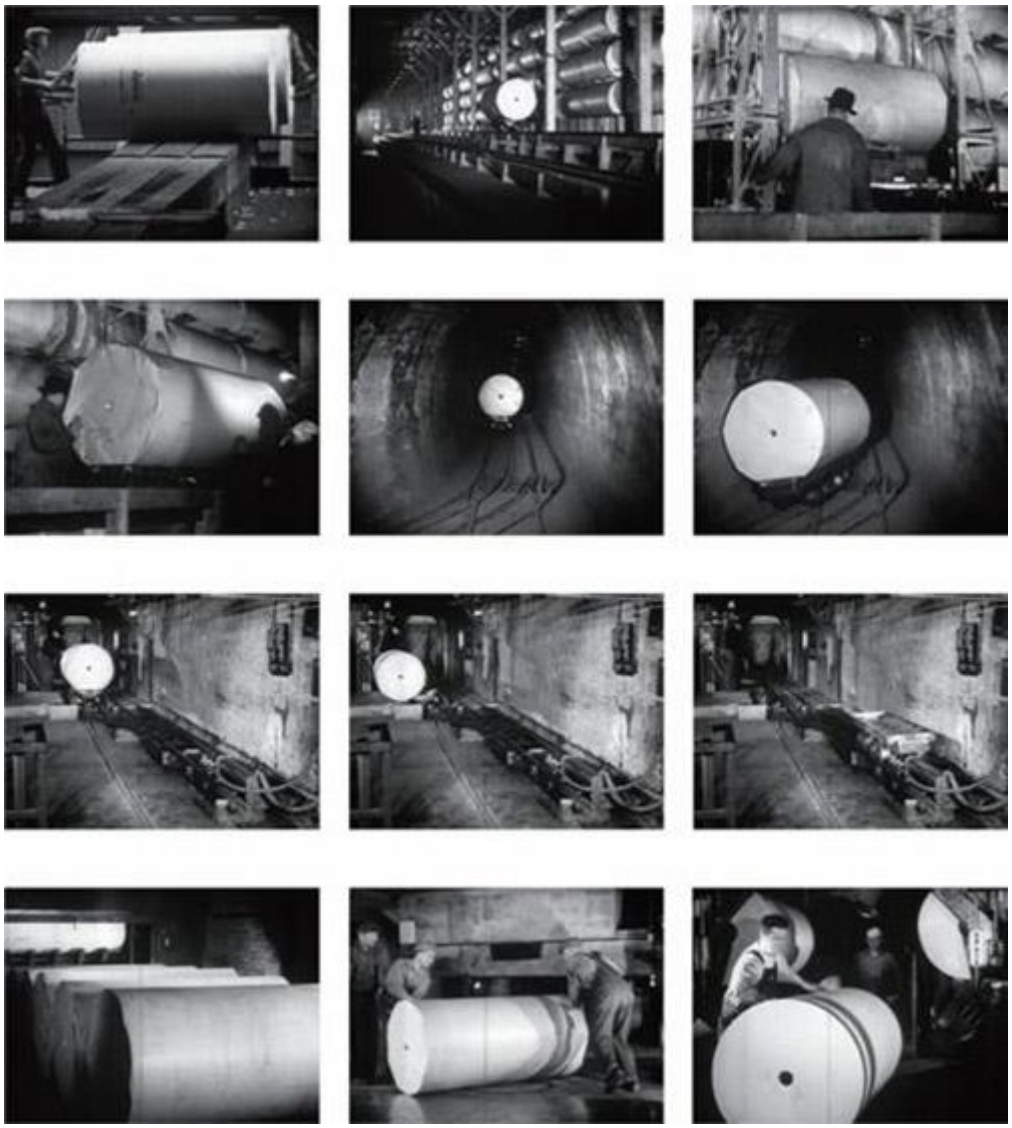
Short film showing tram tickets being produced: 1–3 a ream of paper is cut down into rolls, to which coloured dye is added; 4 the rolls are stacked ready for printing; 5–6 numbered tickets being printed with a special printing machine; 7–9 strips of tickets are sorted, wired, and then tied with string; 10–12 finally the tickets are guillotined, stacked, and stored on shelves before being delivered.

There are numerous smaller collections of films online[4] and, of course, YouTube. The nature of YouTube means that the films available are continuously changing and for this reason, and the fact that a search for 'printing' returns over 80,000 hits, YouTube films were not included in the Handlist.

The films listed were originally produced for a variety of reasons. Some are contemporary with the technologies they record and were intended either for students or professionals in the field (as a form of education/training or to promote a particular product or company) or for a more general audience (news stories, advertising or recruitment). Others are attempts to document obsolete, or nearly obsolete technologies before they finally disappear; in some cases they are professionally produced documentaries made for television or as education titles, others are the work of enthusiasts who are still using old technology either professionally or as amateurs.

While films that were always intended as documentaries are inevitably the most informative it is the contemporary ones that are the most valuable to social historians and those interested in the history of printing and typesetting technology. They provide evocative first hand evidence of the working environments and conditions in the printing industry throughout the 20th century. Views of factory floors and workshops show not only the kind of machinery that was in use but also the number of people at work, how closely they worked together, the clothes they wore, whether they were male or female, how fast they worked, and in some cases the accompanying clatter of machines. Thus the viewer will learn that visors were popular attire for compositors and that in a factory producing tram tickets female workers (supervised by a well-dressed male overseer) tied strips of tickets together with string at incredible speed [5]. Films of newspaper production show banks of Linotype machines with their operators, lines of men assembling type into pages, and the ingenious mechanical systems that different news rooms used to deliver copy to those operators – and in one case to deliver paper to the presses [6].

5. From trees to Tribunes (1937) www.archive.org



Paper delivery to the Chicago Tribune: 1–2 Paper is delivered straight from the ship into a warehouse; 2–9 Reams of paper are then loaded onto a dolley; 4–7 The dolley travels on to Tribune Tower on train tracks in an underground tunnel before being unloaded onto a ramp at the other end by a mechanical tipping device; 8 The empty trolley returns to the warehouse automatically; 10–12 Reams of paper are then lifted up to the press room and taken to the presses.

6. From punch to printing type (1985) www.rarebookschool.org

The final stages of justifying a matrix: 1–5 Botching the matrix (widening it in order to correct the positioning of the character on the body of the matrix); 6–8 Filing a notch on the back of the matrix; 9–10 Filing leather grooves on the back and then the front of the matrix; 11 Punching identifying marks into the matrix; 12 The finished matrix ready for casting.

As visual records of both the working methods and the working conditions of specific companies films can add a huge amount to the existing written and oral history of printing and typesetting in the 20th century. They have the advantage of showing things as they really were whereas written accounts or interviews with workers, particularly those produced many years later, are often coloured by personal views and a tendency to view the past through rose-tinted glasses. This is a useful reminder that films should not be taken entirely at face value – factory floors may be tidier than normal, with workers better dressed, and perhaps more productive, than they would have been in the absence of a camera. In The creation of a printing type

Frederic Goudy is shown wearing a smock while at work in his studio drawing and cutting a letter Q for his Saks typeface. One of the inter-titles explains that Goudy does not normally wear a smock and has only done so for the film – without this explanation the viewer would be left with a totally false impression of how Goudy dressed for work. However, for information such as the number and type of printing presses or typesetting machines in operation films can provide an invaluable, often unique, record.

In some cases the very existence of the film is interesting and says something about the state of the industry at that particular time – for example in the 1970s the International Typographic Union felt it necessary to produce New World of ITU which explained to their members the benefits of introducing computers into the composing room; clearly these workers were worried about their skills as Linotype or Monotype operators becoming redundant and were resistant to these changes.

Newspaper production is by far the most prevalent subject – around 40 of the films listed are related to newspaper printing and these tend to be extremely repetitive. Many are from the British Pathé Archive and only show a few seconds of newspapers being printed without any explanation of what is shown. The rest generally show newspaper production from the collection and editing of news stories to printing from curved stereotype plates via Linotype typesetting. The only one which focuses entirely on typesetting and printing is Farewell ETAOIN SHRDLU: an age-old printing process gives way to modern technology, which documents the last day of Linotype production at the New York Times in 1978 and the changeover to phototypesetting.[5] Similarly, two films about production of the World book encyclopedia at Lakeside Press in the US document the change over from rotary letterpress in the first film to offset-lithography in the second (in both cases using Monotype hot-metal typesetting). There are numerous other films on book production, which in general are much more varied than the newspaper films, reflecting the more disparate nature of the industry. They cover a range of different printing and typesetting technologies from the use of hand presses or vertical letterpress machines to large rotary presses and some even document the production of specialist kinds of books such as telephone directories. Letterpress printing by hand features in a large proportion of the films although often very briefly as part of a historical overview. Of those films that focus on manually operated letterpress machines the most informative are a series of films, three on the iron press and one on the common press, produced in the early 1970s by the Institute of Bibliography at the University of Leeds. A much shorter and less slow-moving explanation of printing using a common press was produced by Stan Nelson and

John Paulson in 1996 – this is also the only film to show the beater and puller working in tandem. There is also the excellent Stephen Fry documentary The machine that made us, which features Alan May's reconstruction of a Gutenberg press. The best explanation of foot-operated treadle presses is an amateur production, Ten presses and how they work, by Duane C. Scott which despite obvious flaws, such as the voice over being drowned out by the noise of the presses, is the only film to show treadle presses in any detail.

7. The World is Round (1935) www.britishpathe.com

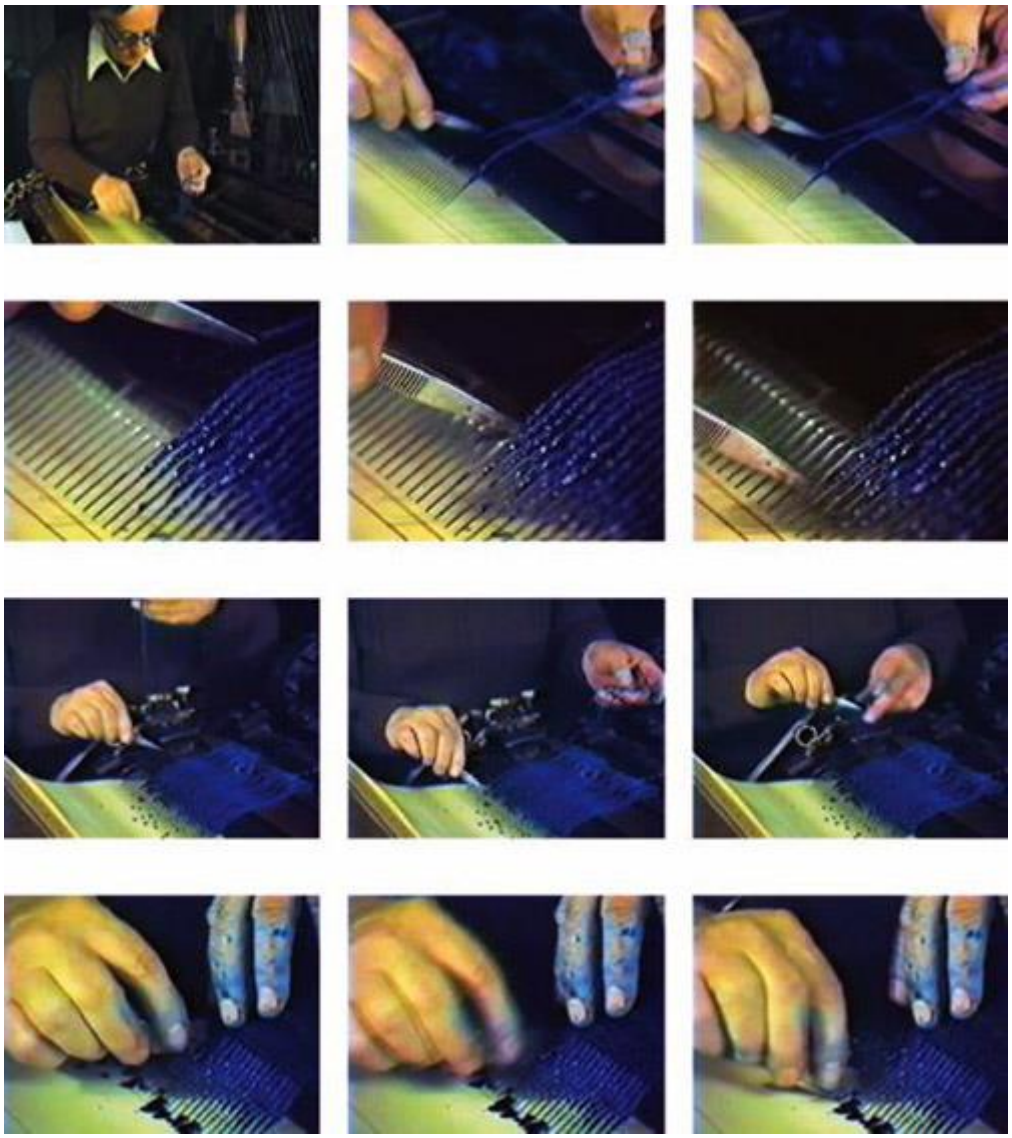
Globes being assembled after printing.

Arguably the most valuable films are not those that show the relatively everyday production of books and newspapers but those featuring the production of more unusual printed items which often required specialist equipment or machinery: maps and globes; stamps, money, and bonds; tickets and ledgers; postcards and greeting cards [7]. Such footage is rare and is even more valuable given that most written research also tends to focus on book and newspaper production. Unfortunately films on these subjects tend to be short and give little or no explanation of what is taking place. Two exceptions are Sharp as a tack, a film about how sheet music is made by hand using special punches and engraving tools, which includes excellent footage of an engraver at work (available online from www.henle.de) and Pen-ruling: a vanishing craft which shows the production of multi-coloured ledgers using a pen-ruling machine [8–9].

8. Sharp as a Tack: music engraving an art and a craft (1997) www.henle.de

Engraving sheet music: 1–2 Preparing the plate – staves being cut with a five-pronged rule and sketching out the notation with a steel nib; 3–6 Using steel punches to add notation into the plate; 7–9 Cutting a slur into the plate freehand; 10–11 Smoothing the reverse side to reduce the tension in the plate; 12 Marking a sign for correction with a pincer.

9. Pen-ruling: a vanishing craft (1985) University of Reading / Rare Book School



Preparing the press for printing: 1–9 loading the pens with ink-soaked strands of yarn; 10–12 cleaning the pens.

Many printing and typesetting technologies are not adequately covered by the films discovered to date. Stereotyping, rotogravure, offset-lithography, phototypesetting, and early digital typesetting and production are shown in numerous films but usually without a satisfactory explanation. It would be well worth recording these technologies before it is too late and indeed to make new films of those that have already been covered – many of the existing films are of extremely poor quality, often being many generations removed from the original 16mm or 35mm film, or were made using equipment that cannot compare to modern digital video technology. This is not to say that the existing films are not of great value and, where

possible, it would be highly beneficial to track down the original recordings and obtain good quality copies. In other cases there are films that attempt to explain their subject but which do so poorly. For example there are several films that show wood-engraving but this is an area that is desperately short of good material. The best two films are only available in the 'Doc' Robert Leslie collection at the University of Virginia. Barry Moser: a workshop in wood-engraving shows Moser giving a demonstration to a group of students and is useful but under-edited. Xylography or the era of wood engraving is actually about the era of woodcutting but has footage of wood-engraver Robert Blanchett at the beginning and the end – the French version of this film is still available from www.libraprim.com. The single film on the subject found in the UK to date, The art of wood engraving, is notable only for that reason. The Leslie collection also has two films on woodcut printmaking: Japanese woodcut workshop: a course in four sections by Izumi Kuroiwa (available from www.imcclains.com) and Woodcuts by Rigby Graham but these are recent films about the making of artistic prints and do not cover either the history of woodcut or wood-engraving or their application in the world of commercial printing.

There are clearly many more films out there and as they come to light the Handlist will continue to grow. The duration of the research project was short and aimed to catalogue specific collections of films – the British Film Institute, the University of Virginia, the University of Reading and those available online. There are many other avenues to pursue – companies such as Monotype, Linotype, Heidelberg, Apple, and Microsoft may have relevant material and there are numerous libraries and archives to investigate including the Wessex film & sound archive and Oxford University Press in the UK, and UCLA and Murray State University in the US. St Bride Library in London has a collection which have not yet been documented because they do not have a viewing facility (most of their films are on 16mm or 35mm film) and it is hoped that by the time this article has been published that these films will have been converted and added to the list. I would be delighted to hear from readers who know of other collections or could contribute entries on films not in the English language. Please contact r.e.banham@reading.ac.uk.

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[1] Feature films were not included in the study. Alastair Johnston at the Poltroon Press has compiled a list of feature films and television programmes which show printing: www.poltroonpress.com. Eventually I hope to produce a fully searchable database but for now A handlist of films showing printing & typesetting is available to download in pdf format from http://stbride.org/library/collections/films. If there any readers with specialist knowledge who have seen any of the films listed and can add to, or correct, the information in the list I would be most grateful.

[2] All of the films in the Department's collection can be made available to visiting researchers by appointment.

[3] The higher quality versions are available free for classroom use in UK Maintained Schools

[4] see www.typeculture.com, www.katranpress.com, www.metaltype.co.uk

[5] ETAOIN SHRDLU are the first two vertical rows of keys on a Linotype keyboard, equivalent to 1QAZ 2WSX on an English qwerty keyboard.

Technology as a social collective experience of nation building: David Nye's American Technological Sublime

By M. Luísa Sousa*

Introduction

David Nye's American Technological Sublime[1] published in 1994 is one of the recommended books for the basic bibliography in history of technology by the Society for the History of Technology, in particular for American historiography of technology.[2] In 1995, a review in Technology and Culture presented it has a "new synthesis of the meaning of technology in American culture,"[3] but, according to its reviewers, its audiences were not only History of Technology or American Studies' academics. It was also a recommend book for environmental historians, as well to professionals of technical areas and general readers.[4] What may justify this range of audiences is not only the elegant and clear writing but the relations explored by David Nye between technology, nature, and people. Moreover, the book raises important historiographical and methodological questions and covers several levels of analysis and themes, providing a challenging regard on different socio-technological phenomena.

American Technological Sublime follows a previous book by David Nye, Electrifying America: Social Meanings of a New Technology, 1880-1940,[5] getting back to it in the two chapters on the electrical sublime, and also working on a social construction of technology,[6] a contextualized approach in History of Technology.[7] The narrative is made using several levels of analysis: the actors that Nye gives voice to range from participants in public events to American corporations. He gives the readers the "flavor" of each epoch using citations from historical actors and showing how it is possible to undertake an analysis at a micro level based on a detailed work on coeval sources drawn from secondary and primary sources, such as newspapers, official speeches, ego-documents (for instance, letters or diaries). He portrays both how Americans related to the technological sublime and the European foreigners' regard on aspects of American culture, society, and technology. Nye also covers topics as diverse as gender, class, and racial issues, and also economic, cultural, and ethnographic aspects.

Giving an emphasis to the discontinuities rather than the continuities (which is an important debate within the historiography of technology, although not addressed explicitly by Nye), the book is chronologically organized, following Nye's proposal of presenting a diachronic approach to a set of cases of technological sublime in the United States of America (will be named simply as "America"), from 1820 to the 1990s. The technological sublime surpassed the natural sublime of the American landscapes when machines such as the railways, telegraph or the steam boat triumphed over space and time.[8] Besides the railroad, other cases of technological sublime analyzed by the author go from the skyscrapers, the factories and the electrified city, to the 1939 New York World Fair, the atomic bomb and Apollo XI, the Statue of Liberty and, finally, the consumer's sublime. He opted for analyzing the appearance of new ways of sublime, each case a chapter, which emerged and validated new social and technological conditions.[9]

While revisiting this book a special attention will be given to the words of its title: the concept of sublime, and particularly of technological sublime, is presented as defined and limited by the author; and its "American" character and the construction of national identity will be discussed through the "lens of technology."[10] With this selection I am interested in the way David Nye positions his work in the History of Technology, how he thinks the relation between nature and technology and the differences between European and American technological cultures.

The assumption that the American technological sublime "experienced in a crowd"[11] is present in all these themes and allows Nye to give voice to generally silent historical actors and relate the construction of the American national identity with its technological culture, which is the basis for the thesis of the book. Because he defines the sublime in America as a collective phenomenon, most of the examples[12] given have to do with events, including "public demonstrations," such as: tourism travel; the sightseeing of American natural beauties (natural sublime); the inaugurations of new technologies or architectural forms (railways, bridges, skyscrapers - dynamic and mathematical technological sublimes); tours to the factories (industrial sublime); other type of mass events, for instance the celebrations of the National Day of American Independence, July 4, or the World Fairs. The analysis of the emergence of a nationalist sentiment lies beyond the study of the positions of the ruling elites or other politically active groups. It is not only about a "top-bottom modernization,"[13] but it is about how the average American has related himself or herself with this modernization.

"Technological sublime" and its "American" character

The sublime concept

> Rather [than other definitions of sublime, the concept of sublime here explored], it is about repeated experiences of awe and wonder, often tinged with an element of terror, which people have had when confronted with particular natural sites, architectural forms, and technological achievements. This book is about the social construction of certain powerful experiences in industrial society, which is to say it is about the politics of perception. It does not primarily concern literature or the arts, but rather the public's experience of particular technologies.[14]

The proposed definition of the American sublime by Nye in this book, discussed in the first couple of chapters, is initially framed in two ways. On the one hand, he frames the concept of the sublime in American historiography through the survey of works that dealt with, in particular, the technological sublime. This term was baptized by Perry Miller in The Life of the Mind in America and later resumed by Leo Marx in The Machine in the Garden.[15] Other American authors who studied the sublime were John Kasson, Barbara Novak, Roland Marchand and John Sears, who analyzed the technological sublime in relation to American tourism in the nineteenth century.[16] On the other hand, Nye does a kind of "History of Ideas" to the concept of the sublime. It begins by tracing the historical evolution of what was considered sublime in various periods in antiquity, in the Middle Ages, and during Renaissance (with the marginalization of the sublime in literature), during the discovery of new worlds (and its association with wonder), during the birth of American nationality and its identification with the landscape, the Enlightenment (the primacy of reason, the desacralization of nature and the birth of modern science), and how nature has not been interpreted as sublime in the centuries that mediate Antiquity and the Enlightenment.[17] Then, Nye dialogues with works by two eighteenth-century philosophers who thought about the sublime, the Irish philosopher Edmund Burke (Philosophical Enquiry into the Origin of Our Ideas of the Sublime and Beautiful) and the German philosopher Immanuel Kant (Critique of Judgment), structuring from there some notions he returns to throughout the book. From Burke he worked the association of the sublime to nature and the necessary experience of shock and awe before the sublime; from Kant, the distinction between beautiful and sublime (defined as a gendered distinction) and the

notions of dynamic sublime and of mathematical sublime (which is also called by Nye as geometric or arithmetic).[18] Nye used these references to better define the particularities of American forms of sublime.

Initially, the European influence, particularly the ideas of fine arts, literature and philosophy in Europe, dominated a particular American notion of the sublime accessible to the elite,[19] which would detach from this model in mid-nineteenth century.[20]

In the United States the sublime took a different turn, for a variety of political and economic reasons. (...) Engineers, rather than architects, built the first man-made objects that Americans regarded as sublime, and what particularly distinguished their response from that of the classical age or the English Enlightenment was the focus on moving machines.[21]

> ... the reemergence of the natural sublime in the eighteenth century soon led to technological versions of the sublime that have persisted down to the present. Nineteenth-century engineers, architects, and inventors were hardly rational technicians, and they often embraced transcendental ideas. Along with clergymen, writers, and artists, they imbued technology with moral values. Likewise, ordinary Americans repeatedly demonstrated en masse their love of technological objects, from the Erie Canal and the first railroads to the space program of the 1960s and the 1987 celebration of the Golden Gate Bridge.[22]

Apart from the this feeling of the sublime (dynamic and mathematical) based on the contact with the natural world (such as the immensity of the Grand Canyon) or on the influence of the European elite culture, Nye develops the various types of technological sublime appreciated by Americans - the dynamic, the mathematical the industrial and electric - and a final form of the sublime, the sublime of the consumer.

The division that Kant made of the experience of the sublime in mathematical and dynamic is based on the subjective experience between subject and object, namely on the subject's perception of something larger than himself.[23] The mathematical sublime is an encounter with something extremely large or of great magnitude, i.e., it is the idea of the infinitely large (which in reality is finite) that one has before things of unique dimensions of or considered huge. Referring to Kant's work once more, Nye relates this with the subject's experience: "In the presence of this apparent infinity, Kant's subject experiences weakness and insignificance, but then recuperates a sense of superior self-worth, because the mind is able to

conceive something larger and more powerful than the senses can grasp."[24] The dynamic sublime has to do with the contemplation of scenes that may raise the element of terror, without one feeling in real danger. This is the kind of sublime that happens when one witnesses (in safety) forces of nature such as floods or explosions of volcanoes. Nye appropriates these concepts and applies them both to the natural and the technological sublimes. The examples the author uses to the dynamic technological sublime are trains and telegraphs and the mathematical technological sublime are bridges, skyscrapers, and dams.

Besides these two types of technological sublime, Nye proposes two others: the industrial and the electrical technological sublimes. The industrial sublime has to do with the sublime image created by organized and disciplined labor in American factories, whose evolution between 1830 and 1930 was marked by the different sources of energy used (water, steam and electricity), the various architectural forms and work models associated, culminating in the assembly line and in production of automobiles.[25] The electrical sublime partially overlapped the mathematical sublime,[26] by eliminating familiar spatial relations, as happened with the metropolis lighted at night.[27] The first chapter on the electric sublime is about how it interacts with the natural and the technological sublimes and what seems to create bonds of social solidarity, albeit fragile. The second places the electrical sublime in a specific context, the city. With the significant development of lit advertisements, a "geography of everyday life" incorporated spectacular effects possible with electricity, which initially were only seen in International Exhibitions.[28] The last form of the sublime presented by David Nye, the consumer's sublime, is quite different from the technological sublime, regardless the genre (mathematical, dynamic, industrial or electrical), because this later celebrates rationality, work and human achievements, while the consumer's sublime privileges irrationality, chance and discontinuity, placing the emphasis on fantasy.[29]

The popular sublime, experienced by a mass audience differs from the sublime defined by Philosophy, because it is articulated in a less clear way and is based on the perceived experience.[30] This perception is accompanied by a relatively specific palette of emotions and states: excitement, enthusiasm, fear (without, nonetheless, sense of threat to its own life), religious feeling, sense of social cohesion,[31] temporary feeling of transcendence, expectations. Expectations about the object of sublime define the experience. If there are none, there will be a psychological progression: firstly, there is a normal behavior, because one does not anticipates that will witness something extraordinary; secondly, the subject realizes that something extraordinary is going on, which disrupts the normal perception; and thirdly, the subject

recovers from the shock and establishes a new relationship with the object of the sublime.32 However, in most natural and technological sublime experiences there is no psychological progression, because there are pictures, stories, and therefore, the subject has already raised expectations, as it happens with tourist places. Moreover, dialogue between expectations and what is seen in fact, will be part of the tourist experience.[33] Every so often, these expectations interfere with the experience of the sublime, as Nye exemplifies with the Niagara Falls or the Grand Canyon, either retarding the direct experience of the sublime to take place by overlapping the prejudices and expectations that tourists bring, or preventing this experience to occur. However, despite the expectations and prejudices, sublime is still accessible to modern tourists, although the fact that its need to have everything well labeled, packed and easy to use is a clear expression of the triumph of the consumer's vision.[34]

The limits of the technological sublime: ambivalence and the naturalization of technology

> During each generation the radically new disappeared into ordinary experience.[35]

The ephemeral character of the technological sublime raises questions about its way of acceptance and rejection, about domestication and naturalization processes, which occur when new technologies are part of new social relations.

Technology materializes relations of power and conflict, opposing social, cultural,[36] and political groups. Power relationships created through technology contain in themselves ambiguities that reveal the technological sublime's internal contradictions, which results from the expansion of human power, as an assertion of rationality, and simultaneously provokes feelings in the individual of insignificance and impotence. Also, depending on the positioning of the actors, one verifies that the distribution of power is unequal: "… those who have the greatest political, economic, and social power are more likely to find themselves inside the panopticon,[37] surveying the vast surround."[38] Technology becomes the mediator of power relations between people and between what surrounds them, and of the power relations embodied in the new landscapes created, as in the case of the skyscrapers (mathematical sublime) and trains (dynamic sublime):

> Within a generation, many considered the tall building to be sublime, particularly seen from the top, just as the railroad was popular when considered from the passenger's point of view. In each case, using a new technology, Americans defamiliarized a known landscape and invested it with new meanings. The geometrical sublime, like the dynamic technological sublime before it, provided an olympian sense of perspective that could be immediately translated into a sense of power over nature. In each case, the human cost of achieving that power was literally invisible to the inhabitants of the new technological structure.[39]

Nye refers to the invisibility of the human and other costs of new technological to stress the little resistance manifested by people when experiencing a new technological sublime. For instance, in 1939 New York World Fair, the highways of the future showed in pavilions of corporations such as General Motors and Ford[40] were utopist visions of a landscape dominated by automobility, which erased all the factors that would represent the costs of the use of these systems' technology to society, such as noise, pollution, road safety, poverty, war or unemployment.[41] The exhibition of new consumption goods in twentieth century World Fairs (which was not made in the nineteenth century International Exhibitions) was made through the representation of ideal landscapes without people or problems. Another example of the limited resistance to new technologies, or the initial invisibility of its costs is the railways. Nye argues that during the initial expansion of railroads in America[42] there was a broad consensus on the fact that they were sublime, and that they contributed to the unification, enrichment and expansion of the nation,[43] despite rejection, caused either by social conflicts over defrauded expectations (railways contributed to uneven regional growth), or by accidents involving steam engines.[44] On the skyscrapers, Nye says the struggles over its location repeated a pattern similar to other technological innovations: "As in the case of the railroad, a technological innovation excited the popular imagination at its inception and overcame all opposition."[45] Although there are several studies in the History of Technology that reflect the reality of resistance to the introduction of new technologies in the social fabric in its initial phase,[46] including some of David Nye's works,[47] this stance is probably due to the choice of the theme of the book, the sublime, which presupposes a more triumphant view of technology. The argument made by Nye about the little importance of resistance to new technologies goes together with the assumption that, initially, Americans did not necessarily see a contradiction between nature's conservation and technological development, whilst recognized the existence of tensions and

sought the sublime in both nature and technology.[48] For example, Nye compares the landscapes created by the initial location of factories in England and America, due to the use of different energy sources, respectively, in cities (steam) and the country (water).[49] For Americans, at the outset, the presence of factories in rural areas did not excite a feeling of contradiction, as it did for the English: "As with the railroad, Americans at first believed that factories might not pose a contradiction to the natural world but might extend and complete it."[50]

Linked to the relationship between nature and technology, is the question of "naturalization" of technology in the sense that technology is made an element of nature, addressed promptly. According to Nye, there is sometimes even a lack of clarity regarding the definition of the two domains: "The assumption of human omnipotence has become so common that the natural world seems an extension of ourselves rather than vice versa."[51] The naturalization of technology, in the sense of technology becoming a "natural" part of the world, also assumes that it ceases to cause awe: each object exceeds its predecessor, which is in the meantime naturalized. Both naturalization and replacement are constituents of the sublime.[52] One could say that what Nye defines as "life-world" becomes a life-techno-world. The dialogue ceases to be between man and nature to be between man and his accomplishments, i.e., the manifestations of reason, placing a new emphasis on the role of engineers: "The awe induced by seeing an immense or dynamic technological object became a celebration of the power of human reason, and this awe granted special privilege to engineers and inventors."[53] This naturalization of technology also contains an assumption about the neutrality of technology that, according to Nye, was only called into question with the atomic bomb, which was "the ultimate dead end of any attempted representation of the technological «thing in itself»."[54] This assumption on the harmony between nature and technology would have lasted in America between 1820 and 1945, the year the atomic bomb showed the other side of technology. But as "history is not a philosopher's argument,"[55] instead being made by factors that do not necessarily converge to a rationality,[56] Americans of the late twentieth century forgot the impasse posed by the technological sublime, and did not stop to enjoy it after the atomic bomb dropped on Hiroshima.

The naturalization of technology is also perceived as vulgarization and domestication of technology: in every object considered sublime, this quality is ephemeral and the object becomes vulgarized. This process is visible in the examples of technological sublime presented by David Nye, like the railways, bridges, public lighting, or the skyscrapers. However, no matter the efforts made, the atomic bombs will never be tamed or vulgarized: they will always be "a

permanent, invisible terror that offers no moral enlightenment"[57] and therefore serve as limit to the definition of technological sublime. The domestication of technology is associated by Nye to a process of feminization, reinforcing a notion of separate spheres according to gender. Although women had been marginalized, but not totally excluded from the production of the technological sublime (it was were mostly a product of the "male gaze"[58]) Nye claims that they "played a vital part in the incorporation of the technological object into ordinary life" and that this process of "feminization transformed the alien into the familiar and implied the emergence of a new synthetic realm in which the lines between nature, technology, and culture were blurred if not erased."[59] According to this perspective, women have played an active role in the "naturalization," "domestication" or the "appropriation" of technology.

Subjacent to the naturalization of technology is the concept of continuous improvement and the belief in technological progress: what was considered technological sublime ceases to cause such admiration and expectations are created about a faster, bigger or more complex technology.[60] This cycle (virtuous or vicious?) seems a paradox. The technological sublime contains both the idea of reason in constant evolution and the idea of permanent dissatisfaction. This idea of continuous progress was also conveyed during the international exhibitions, including New York World Fair in 1939: "This mingling of the marvelous and the real prepared visitors to see new consumer goods in terms of an inevitable march of progress toward a technological future."[61]

The evolution of forms of sublime also undergone a change of discourse: in America in the late twentieth century, words were no longer needed to explain that technological objects were sublime, and were replaced by non-verbalized performances, unlike the initial celebrations of the first forms of technological sublime, as the trains, which were accompanied with explanatory speeches that helped to create meanings. Nye makes this general appreciation about the centennial celebration of the Statue of Liberty:

> ... the history of the technological sublime is that of the movement from word to spectacle, from individual to crowd, from nature to the machine, from substance to electric image. Its history records a shift in emphasis from natural to artificial landscapes, a shift that simultaneously transformed the position of the subject in relation to the sublime object. (...) ... by the late twentieth century the omnipotence of engineering had been internalized. It was no longer necessary to declare that machines were sublime.[62]

There were continuities in this evolution of the technological sublime, such as the creation of a feeling of personal and national transcendence, which includes the feeling of community cohesion, though ephemeral. To witness the sublime was also a break from the ordinary everyday life, it was something extraordinary. But there were also discontinuities: "Gone were the visible links between work and product, between commerce and politics, between technology and human agency."[63] The way sublime was celebrated also changed. People became more spectators, tourists and consumers than active participants:[64] "To the public, the technologies that Ronald Reagan put into play by pushing a button at the 1986 event [the centennial of the Statue of Liberty] were anonymously spectacular."[65] And here is one possible conclusion from the technological sublime's developments and changes in general, regarding the relationship between people and technology: the button has become the mediator between technology and human agency.

To finish the delimitation of the concept of the sublime it is necessary to address what Nye calls the "life world" and "death world." The sublime is an experience associated with self-preservation and therefore also associated with a "life-world," which means that nature and human existence are taken for granted in a world full of possibilities.[66] The atomic bomb is the unique example of sublime that David Nye provides in his book that puts into question this world, creating the possibility of a "death world," i.e., the possibility of world destruction and the extinction of the human species.[67] However, this did not prevent that a kind of atomic tourism existed,[68] or that the discussion of the use of nuclear energy for peaceful purposes, namely to solve energy problems, occurred. But the sublime that could be inspired by the nuclear energy and the atomic bomb is in contradiction with the classical sublime, for it contains the possibility of annihilation of nature, and also contradicts the technological sublime, which is manmade, because by containing this possibility, it destroys the collective feeling of human achievement.

Technological sublime and the construction of American identity

David Nye defines the "American" character of the technological sublime through the comparison with the "European" case, and also by revealing the relationship between American technological culture with politics and religion.

Nye uses Europe as a counter-example of identity from which the Americans have distinguished themselves from, making a very interesting reflection on the role of technology to the Europeans and the Americans. Being an American historian who has lived and taught in several European countries, the current being Denmark,[69] David Nye acknowledges what might not be enough said, although explored by a recent European project in the History of Technology that studies the "Americanization" of European consumer society,[70] which is the statement that "American" and "European" technological cultures are different. Either by studying the ""Europeanization" of American and the way American culture gradually differentiated from the European, or studying the "Americanization" of twentieth century Europe, the assumptions are the same: there were mutual influences and differences of their technological cultures. Stating this difference, Nye emphasized the Americans' relationship with technology (and with the technological sublime) to the construction of America's identity as a nation, and presented it as an American exclusivity.

Americans have long found the sublime more necessary than Europeans, so much so that they have devised formations of the sublime appropriate to their pluralistic, technological society. Precisely because American society is so pluralistic, no single religion could perform that function. Instead, ever since the early national period the sublime has served as an element of social cohesion, an element that was already quite evident when the first canals were dug and steam engines were first harnessed to trains.[71]

Europeans neither invented nor embraced the vertical city of the skyscraper. Europeans banned or restricted electric signs, and rightly saw the landscape of Times Square as peculiarly American. Europeans did not see atomic explosions as tourist sites. Europeans seldom journeyed to see rockets go into space, but Americans went by the millions. There is a persistent American attraction to the technological sublime.[72]

This provocative stance of the American exclusivity of the experience of the technological might be debatable. An example is the relationship between landscape and the development of tourism and the discovery of the country, which was not an American exclusive experience. According to Nye, the Americans turned to the landscape in search of the national

character, stressing that few monuments were erected before the Civil War.73 The American landscape was perceived with pride when compared with Europe, which had no such wonders:[74] "As Americans became tourists in their own country, interest in sublime landscapes became not an idle diversion but an act of self-definition."[75] However, this presentation of tourism as an American nationalist distinctive feature when compared to the European experience is something worth questioning. Actually, Europe had monuments and other heritage in this period that were signaled for protection and conservation, but Europeans also enjoyed the countryside and natural landscapes and associated it with a discovery of their own country: "visiting the countryside, appreciating the scenery was a patriotic duty as well as a pleasure."[76] Another example, perhaps more general, is the recognition of recent historiography of the role of science and technology in the construction of nineteenth century European liberal States.[77] During the nineteenth and twentieth centuries, the transformation of the landscape was quite marked by the relationship between nature and technology and the technological achievements that represent both dynamic sublime, like trains and telegraphs, and mathematical sublime as dams, bridges, or skyscrapers. Transport infrastructures, such as railways, have reshaped the country and created new nodal points, including cities, producing a landscape that reflected the marginalization of rural issues.[78] Considering how the development of communications contributed to the construction of national identity is more than assessing how they allowed the central government to reach all parts of the territory, as Eric Hobsbawm suggests.[79] David Nye specifically proposes an approach that goes beyond, by considering the intrinsic value of cultural representations of these technologies and how they were perceived. But again, he insists on the difference of European and American technological cultures affirming that the ambivalence towards technology was always greater in England than in the America,[80] which always manifested greater resistance to new technologies. There were differences (for instance, in general, railways in Europe connected pre-existing cities while in America, mostly in the West, railways contributed to establish new cities)[81] and specificities of each technological culture, which does not mean that Europeans have not experienced technological sublimes.[82]

The "American" character of the technological sublime is also reflected in the relation between its technological culture and politics. David Nye makes other associations between objects perceived as technological sublime and values such as democracy, exemplified by the inauguration of the Erie Canal in 1825:

The citizen who contemplated such public improvements became aware of the power of democracy and saw himself as part of the moral vanguard, leading the world toward universal

democracy. (...) American democratic virtue could not be based on a state religion – that was forbidden by the constitution… (...). Nor could it be based on adherence to ancient traditions, since there were none. But democratic virtue could be invigorated by the powerful experience of sublimity.[83]

Nye goes even further and reflects on the importance of natural and technological sublimes to the cohesion policy and adherence to Republican values: "Since, politics was expected to inspire vigorous debate and continual self-examination rather than automatic patriotism, another realm of unquestioned allegiance was needed to unite the citizenry. Hence, the centrality of the natural and technological sublimes."[84] The celebration of July 4 also exhorted democratic values and, once again, the counter-examples were the models of European undemocratic governments.[85] Regarding international relations, Nye also related the American technological sublime to American hegemonic power: World Fairs in America were a means to contextualize American technological achievements in an international perspective and to include them as part of the American identity.[86]

The "American" character of the sublime is also deeply rooted in religion, for the religious feeling is at the basis of the notion of the sublime, linked to nature.

Protestants increasingly looked for God in "the mirror of his works." Americans would later incorporate this view in a powerful version of the natural sublime. The central point is that the sublime was not part of a static view of the world, nor was it part of a proto-ecological sensibility that aimed at the preservation of wilderness. Rather, to experience the sublime was to awaken to a new vision of a changing universe. The reemergence of the sublime was part of a positive revaluation of the natural world that by the eighteenth century had become a potential source of inspiration and education.[87]

Later on, this religious feeling in the relationship with the natural sublime was also suitable for the technological sublime. Nye quoting Leo Marx states that "... the awe and reverence once reserved for the Deity and later bestowed upon the visible landscape is directed toward technology, or rather the technological conquest of matter."[88] This sense of re-bonding is explained by Nye as a counterpoint to the increasing desacralization of the American society:

The technological sublime is an integral part of contemporary consciousness, and its emergence and exfoliation into several distinct forms during the past two centuries is inscribed within public life. In a physical world that is increasingly desacralized, the sublime represents a way to reinvest the landscape and the works of men with transcendent significance.[89]

A final comment

This book offers a challenging overview of the relation between technology, society, and nature, by using the concept of technological sublime as a tool to analyze a set of technological topics. Its richness is truly inspiring for historians of technology, who keep revisiting it.

David Nye brings the feeling of awe, wonder, and often terror, experienced in the presence of a new technological device, to the forefront of the history of technology, exploring its role as a critical tool in the construction of both the concept of modernity and national identity. On the one hand, Nye gives voice to the people (not the elites) who experienced the "popular sublime," an innovative "bottom-top" analysis of modernization; on the other hand he analyzes the role of technology as an important feature for the construction of national identity, both in the material and the representational levels (force shaping the landscape and of social cohesion).

Although acknowledging the differences between "European" and "American" technological cultures and technological sublimes, David Nye's American Technological Sublime provides an exciting general conceptual framework which can be used in different scenarios still to be explored.

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[1] David E. Nye, American Technological Sublime, (Cambridge, Mass./London: The MIT Press, 1994).

[2] See http://www.historyoftechnology.org/bibliography.html (accessed on the 27th November 2010).

[3] Jeffrey L. Meikle, "Review: American Technological Sublime by David Nye," Technology and Culture, 36, no. 4 (1995), 1021-1022: 1022.

[4] See, for instance, Kirk Jeffrey, "Reviewed work: American Technological Sublime by David E. Nye," Environmental History Review, 19, no. 2 (1995), 85-87; David Simpson, "Review of American Technological Sublime, David E., Nye," IEEE Transactions on Professional Communication, 39, no. 4 (1996), 242-243; Joe Podolsky, "Book Review, American Technological Sublime, David E. Nye " Computers and Society, 26, no. 1 (1996), 25, 26.

[5] David E. Nye, Electrifying America: Social Meanings of a New Technology, 1880-1940, (Cambridge, London: The MIT Press, 1997 [1990]).

[6] Nye, American Technological Sublime, xv. For the classic work on this approach see Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch, eds., The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology, (Cambridge, Mass./ London: The MIT Press, 1994 [1987]).

[7] See John M. Staudenmaier, "Rationality, Agency, Contingency: Recent Trends in the History of Technology," Reviews in American History, 30, no. 1 (2002), 168-181; Technology's storytellers: Reweaving the human fabric, (London, Cambridge: The MIT Press, 1989).

[8] Nye, American Technological Sublime, 56.

[9] Ibid., xvii.

[10] The expression "lens of technology" is borrowed to the agenda of a network that studies History of Technology in Europe, called Tensions of Europe. See, for instance, Thomas J. Misa and Johan Schot, "Introduction. Inventing Europe: Technology and the Hidden Integration of Europe," History & Technology, 21, no. 1 (2005), 1-19.

[11] Nye, American Technological Sublime, 27.

[12] David Nye explains the selection criteria for the cases presented: "First, I have searched for the things that awed the public. Second, I have focused on phenomena that attracted maximum national attention (...). … I have examined experiences which ordinary people have intensely valued." Ibid., xvi.

[13] Hobsbawm makes the caveat that most of the studies on nations' formation and nationalist movements omit a level of analysis from the bottom, i.e., from ordinary people, often not literate. Therefore I underline the fact that David Nye, in an ingenious way, was able to approach this vision. Eric J. Hobsbawm, A questão do nacionalismo. Nações e nacionalismo desde 1780, (Lisboa: Terramar, 1998).

[14] Nye, American Technological Sublime, xvi.

[15] Ibid., xv.

[16] Ibid. For full references to the books of these authors see, American Technological Sublime, 297, 298. (note 8).

[17] Nye, American Technological Sublime, 1-5.

[18] Ibid., 30 and ss.

[19] Ibid., 21.

[20] Ibid., 1.

[21] Ibid., xix.

[22] Ibid., xx.

[23] Ibid., 9, 10.

[24] Ibid., 7.

[25] Ibid., 130.

[26] "Kant's sublime made the individual humble in the face of nature, the technological sublime exalted the conquest of nature. The electrical sublime represented a third kind of experience, as it dissolved the distinction between natural and artificial sites". Ibid., 152.

[27] Ibid., 196.

[28] Ibid., 177.

[29] The author acknowledges that some kinds of technological sublime also have an "element of escapism," but they are essentially visions focused on progress. Ibid., 295, 296.

[30] Ibid., 27, 28.

[31] Nye draws on ideas about social cohesion of the sociologist Emile Durkheim.

[32] Nye, American Technological Sublime, 12, 13

[33] See, for instance, Catherine Bertho-Lavenir, La Roue et le Stylo, Comme Nous Sommes Devenus Touristes, (Paris: Editions Odile Jacob, 1999); Brian Dolan, Ladies of the Grand Tour: British Women in Pursuit of Enlightenment and Adventure in the Eighteenth-Century Europe, (London: HarperCollins Publishers, 2001).

[34] Nye, American Technological Sublime, 15, 290.

[35] Ibid., 283.

[36] For example, a discussion of what is beautiful in the city, particularly on the placing of electric signs along public roads, put in dispute the defenders of a high culture, who were against it, and the advocates of a popular culture, who were in favor. Ibid., 190.

[37] The principle of the panopticon (proposed by Bentham) is an architectural model that has on its periphery an annular building and a tower in the center. It is the figure in architecture that best symbolizes the pervasive power of those who, from the tower, are not seen but control those on the periphery, who are always visible and don't see who controls them. See Michel Foucault, Vigiar e Punir, (Petrópolis: Editora Vozes, 1993 [1975]), 173-199.

[38] Nye, American Technological Sublime, 285.

[39] Ibid., 100.

[40] General Motors' "Futurama", Ibid., 218. and Ford's "Road of Tomorrow", American Technological Sublime, 215.

[41] Nye, American Technological Sublime, 219, 220.

[42] He situates the expansion of railways in America between the construction of the first railway line in 1828 until the completion of the first transcontinental connection by railways in 1869.

[43] Nye, American Technological Sublime, 45.

[44] Ibid., 70, 71.

[45] Ibid., 99.

[46] See, for example, for the case of resistance to the diffusion of the automobile in America Ronald R. Kline and Trevor J. Pinch, "Users as Agents of Technological Change: The Social Construction of the Automobile in the Rural United States," Technology and Culture, 37, no. 4 (1996), 763-795; Clay McShane, Down the Asphalt Path: American Cities and the Coming of the Automobile, (New York: Columbia University Press, 1994); Peter D. Norton, Fighting Traffic. The Dawn of the Motor Age in the American City, (Cambridge/ London: The MIT Press, 2008).

[47] See, for instance, David E. Nye, America as Second Creation. Technology and Narratives of New Beginnings (Cambridge, Mass: MIT Press, 2004).

[48] Nye, American Technological Sublime, 282.

[49] Ibid., 110, 111.

[50] Ibid., 112.

[51] Ibid., 289.

[52] Ibid., 284.

[53] Ibid., 60.

[54] Ibid., 290.

[55] Ibid., 291.

[56] "History … records not logical developments but a mixture of well-reasoned acts, unintended consequences, accidents, shifting enthusiasms, and delusions." Ibid.

[57] Ibid., 253.

[58] Ibid., 283.

[59] Ibid.

[60] Ibid., 60.

[61] Ibid., 216.

[62] Ibid., 277.

[63] Ibid., 279.

[64] Ibid., 286.

[65] Ibid., 279.

[66] Nye, American Technological Sublime, 228.

[67] Ibid., 231.

[68] Nye describes the promotion of viewing of nuclear tests in Nevada, which people watched as tourist attractions, and as another form of technological sublime. Ibid., 232, 233.

[69] A short biography of David Nye is available at http://www1.sdu.dk/Hum/amstud/staff/david_nye.htm (website accessed on November 29, 2010).

[70] See, for instance, the project "European Ways of Life in 'the American Century': Mediating Consumption and Technology in the Twentieth Century (EUWOL)," which is a Collaborative Research Project (CRP) in the framework of the European Science Foundation's EUROCORES program Inventing Europe. See http://www.tensionsofeurope.eu/Research.asp?wh=EUWOL (website accessed on November 29, 2010).

[71] Nye, American Technological Sublime, xiv.

[72] Ibid., 282.

[73] Ibid., 24, 25.

[74] Ibid., 32.

[75] Ibid., 24.

[76] Catherine Bertho-Lavenir, "How the Motor Car Conquered the Road," in Cultures of control, ed., Miriam R. Levin (Amsterdam: Harwood Academic Publishers, 2000), 129. The European liberal nation states were affirming the legitimacy of their origins and also resorted to the landscape. Catherine Bertho-Lavenir takes her argument a step further, giving us an account that the preservation of the landscape was also a concern of automobile clubs and tourist industry because of car journeys.

[77] See Carol E. Harrison and Ann Johnson, "Introduction: Science and National Identity," Osiris, 24, no. 1 (2009), 1-14. For the Portuguese case see Tiago Saraiva, "Inventing the Technological Nation: The Example of Portugal (1851-1898)," History & Technology, 23, no. 3 (2007), 263-273.

[78] Nye, American Technological Sublime, 64.

[79] Hobsbawm, A questão do nacionalismo. Nações e nacionalismo desde 1780, 78.

[80] Nye, American Technological Sublime, 54.

[81] Ibid., 58.

[82] See, for example, Marta Macedo, "Projectar e construir a Nação: engenheiros e território em Portugal (1837-1893)" (PhD Thesis, Faculdade de Ciências e Tecnologia da Universidade de Coimbra, 2009).

[83] Nye, American Technological Sublime, 36.

[84] Ibid., 35.

[85] Ibid., 41.

[86] Ibid., 68.

[87] Ibid., 5, 6.

[88] Ibid., 58.

[89] Ibid., xiii.

FARA, Patricia, Science: A Four Thousand Year History (Oxford: Oxford University Press, 2009), 424 pp. Hardback. £20. ISBN: 978-0-19-922689-4.

By Josep Simon*

Educational works have always been the quest of great men. One can be learned, but the skill of writing is not a quality that all men possess. Hence, it is a special talent, a rather rare aptitude to have, the faculty of teaching and popularizing! Masters in this art are not likely to leave any memory with us, except the testimony of the students they taught, and the opuscules they wrote, which, in spite of their apparent humbleness, are far more valuable than those heavy volumes, dense in high-flown sentences, full of nebulous theories and, no doubt, completely sterile for humankind, which can dazzle at first sight, but could not really enlighten or instruct.

— F.-N. Moigno, Cosmos (1853), II, 19 mai, p. 513

Patricia Fara's Science: A Four Thousand Year History could have been the object of Moigno's science review, if it was not because she is a twenty-first century writer, a historian, and a woman. In the last decades, Fara has developed a solid career as a historian of science, teacher and writer, characterized by a constant ambition of improvement. Posterity might remember her for this, her hitherto most challenging book. Future historians will tell.

The conception of Science: A Four Thousand Year History lies in the productive interaction of Fara's experience as both a scholar and professional writer, and the practical experience arising from the reception of her excellent Newton: the Making of a Genius (Picador 2003). In this context, the author has combined two major aims: confronting the challenge of writing a new 'big picture' able to replace the old 'From Plato to NATO' narratives. Such picture has to deal with the sophistication, specialization and critical tension between the local and the global, currently characterizing history of science as an academic discipline. Few historians of science have dared to engage in this quest, recently. In addition, Fara aims at expanding and shaping the readerships of science popularization/history of science by offering a product which, while following cultural and commercial trends, has a genuinely historical sensitivity which distinguishes it from many of the books in that market.

A Four Thousand Year History aims at the same fascination that such popular books as John Gribbin's Science: A History, 1534-2001 (Penguin 2003) and Bill Bryson's A Short History of Nearly Everything (Doubleday 2003) caused in the science communication industry and the general public. But Fara's work introduces a different way of narrating the history of science which is faithful to the most recent scholarship in this field. At the same time it cleverly problematizes big subjects such as origins, progress, eschatology and heroism, and introduces prominently others such as social, political and economical interests. The former have frequently exerted a critical fascination in the minds of popular science readers; the latter are often absent in popular science literature.

Patricia Fara's Science is divided into seven sections (Origins, Interactions, Experiments, Institutions, Laws, Invisibles, Decisions), each of which is subdivided into seven chapters – a tribute to the symbolism of that number in human civilization, and a narrative strategy of the author contributing to the compact character of her book. Each Chapter is introduced by a well selected quote which contributes to engage the reader, and with one or two pertinent illustrations. They are short (not much longer than this review) and written as stories which can be read separately. But there is also a general narrative thread linking the book chapters thematically and chronologically from start to end. The emphasis of the book structure is thematic. The linear time scale of more traditional narratives is respected but subtly confined to the background.

With her book, Fara tells us that science is an integral part of culture; that it is shaped by social, industrial and political interests, by ideas as much as by practical experience, and by past events as much as by present developments. Science was different yesteryear and will be different tomorrow, because it is, like its history, a human construction. None of this is new in academic history of science, but the conviction, power and sophistication with which Fara expresses it makes it entirely original. The author of Science teaches us many lessons about the complexity and sophistication of historical writing. Notably, her writing is pedagogically enlightening in combining a clear cancellation of anachronism and presentism with a eulogy of history as an extremely rich way to understand science, past and present.

Her account is also careful and balanced in the introduction of historical actors. Women and workers find their place, and the problem of their biased absence in standard histories is adequately presented. These elements do not push Fara's narrative a step forward, as they do for instance more radically in Clifford D. Conner's A People's History of Science (Nation Books 2005), but, still, they shape her narrative in relevant ways.

Analogously, Patricia Fara's book makes important steps in problematizing 'Eurocentrism' and 'Empire' and it is significant that it introduces balanced accounts on science in early modern Islam and China. However, the author has missed the opportunity of integrating in her account the burgeoning literature on Iberian science and Atlantic history which has already challenged the artificial historiographical boundaries traditionally drawn between the British and Spanish empires. Fara's account is strongest in those subjects that she knows better as a writer and researcher. Overall, her wide thematic coverage is always competent, though. But the real weakness of Fara's global story of science is that unfortunately her lens is mainly British.

A Four Thousand Year History is an admirable big picture chronologically. It has also attempted to be a big picture geographically and in many aspects it manages to do so. It is the work of a highly educated British author with an admirable international outlook and internationalist ethos but, still, Fara depicts the world from a British point of view and addresses mainly Anglo-American readers. The successful translation of her book into other languages will inevitably make this imbalance even more evident. A more prominent place in her story could have been given, for instance, to subjects such as the circulation of people and knowledge, helping to unveil the fragility of national frontiers and their artificial impact on our vision of science and its history.

Nonetheless, Fara's book is the best general introduction to history of science currently available, and a major feat for our discipline. In spite of the aforementioned weaknesses– after all any work has some – Fara's Science will have a major impact in how history of science is taught and practiced during the next decades. Its translation into Spanish (Ariel 2009) and German (Spektrum Akademischer Verlag Oct. 2010) and the publication in February 2010 of its paperback (at half the price of the hardback) are excellent news. The excellence of Fara's work has much to contribute to override the outdated approach presenting history of science as a sequence of Kuhnian scientific revolutions. It challenges too the tediousness of the popular narratives which represent science as an enterprise of geniuses and heroes. Moigno would have surely said: Chapeau! (and doffed his hat in admiration).

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Pimentel, Juan El Rinoceronte y el Megaterio. Un ensayo de morfología histórica. Abada Editores, Madrid, 2010, 316 pp. ISBN: 978-84-96775-67-I.

By Maria Margaret Lopes*

Objects as sites of knowledge: on the instability of the rhinoceros and the megatherium

In "El Rinoceronte y el Megaterio. Un ensayo de morfología histórica, Juan Pimentel – the renowned historian from the Consejo Superior de Investigaciones Científicas de Madri – in a sophisticated manner constructs an argument that it is possible to establish analogies or homologies between disparate episodes separated in space and time. It concerns the production of knowledge about two quadrupeds and their images, originating in India and South America, one in the 16th century and the other in the first half of the 19th century, both icons in the history of the arts and sciences.

The histories narrated in this essay are interlinked in an attempt to track the circulation of fantastic objects and creatures deriving from the human imagination. They are histories about the innumerable aspects that shape the construction of knowledge. For readers of Latin American literature, it is impossible not to associate Juan Pimentel's text with those imaginary beings of Jorge Luis Borges and Margarita Guerrero. To readers of Portuguese history and the history of art, Juan Pimentel proposes the challenge of re-examining images as powerful and commonplace that are present in monuments, in iconography, in historiography. Touching on the rhinoceroses and the empires of Damião de Góis and Abel Fontoura da Costa, and a whole set of erudite bibliography, he proposes the challenge of seeing Ganda – the elephant's cheery and astute enemy, which from exotic attraction will transform itself into a diplomatic object – 'disappear', submerged into an age when Dürer's rhinoceros exalted the imaginary and created an artistic tradition. To readers of the history of Palaeontology, the essay, indebted to a broad range of classical studies of comparative anatomy and especially to the recent works of Martin Rudwick, López Piñero, Francisco Pelayo, Irina Podgorny, among others, picks up the subject of the megatherium, the articulator of a whole structuring controversy within the discipline in the first half of the 19th century.

Rhinoceroses and divers megatheria that appear in these histories – and I prefer to understand them in the plural – share trajectories of descriptive, conceptual instabilities, of 'natural hatreds', of form and function immortalized in their images, from Strabo to Pliny or from Cuvier to Owen, among many others. In their 'circular lives' (to use Juan Pimentel's title to the book's epilogue) Dürer's rhinoceros and the quadruped megatheria of Bru y Navarro or Hawkins' biped (we recall, in an even more persistent image) rapidly escaped their control, became unstable, in the countless reproductions and/or classifications.

In the 'itinerary', in the 'words' and in the 'engraved' subtitles of the first part of the book, it is the 'armed pachyderm' – the rhinoceros – that articulates the construction of arts and sciences on beings from faraway territories through which the Europeans were beginning to circulate. In the second part of the book – a strange cadaver – the megatherium continues to accrue multiple identities such as 'chimera', 'bones' and finally 'fossil'. Like a fantastic being from temporalities in which one can only circulate through the imagination.

In the first part of the book Juan Pimentel lets us know more of the histories of the images of Ganda, Bada, or of Dürer's rhinoceros and less of their natural histories, although there is no lack of these. This movement is inverted in the natural histories of the megatheria of Lujan, Cuvier, Madri, Pander, Dalton and Owen. But, far from becoming established beings in their families or habits, the megatherium of Cuvier acquired from Larrañaga the cuirass that inaugurated its instability. Among others, Pictet imagined it living underground and Lund, with his extensive 'field work' experience in scenes from deep time, imagined it living in the branches of gigantic trees. Why not a carnivore? Palaeontologists continue to imagine. To imagine is just as much their function, as it is that of historians, artists.

As Juan Pimental warns his readers in the first pages, the weakness of this kind of research resides in the fact that the phenomena compared may reveal themselves to be disparate, heterogeneous and immeasurable. And perhaps for this reason, we might add, all the more enticing.

The book may be a source of inspiration for a wide audience. It not only serves to stimulate reflection on interactions in the construction of themes in the arts and sciences, the circulation of knowledge, objects as sites of knowledge, but also reflects on the current construction of the history of scientific cultures.

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Thomas Misa, Leonardo to the Internet: Technology and Culture from the Renaissance to the Present (Baltimore and London, The Johns Hopkins University Press, 2004), XX + 324 pp. ISBN 0-8018-7809-8

By Maria Paula Diogo*

This book by Thomas Misa presents a refreshed approach to intersections between technology and society. Unlike most of the traditional books on history of technology, Leonardo to the Internet presents to the public an account of technology as shaped by different economic and political outsets. Starting from Renaissance and ending at the dawn of the 21st century, cruising along renaissance courts, the age of commercial capitalism, the industrial revolution, the building of the technological landscape of the 19th century empires, the rise of techno-science, the agency of military circles and the globalization, Misa builds a passionate narrative of how technologies are human and social built, changing and being changed by society.

In the preface the author states very clearly that the architecture of the book serves de defense of an argument: Misa clearly disagrees on the deterministic thesis, which sees technology as independent from society though impacting on it, for good or bad. The discussion on technological determinism has been at the heart of history of technology since its beginning and continues to agitate historians, sociologists and philosophers. With a long tradition that goes back to Marx, Sombart, Ogburn, Braudel, Mumford, Marcuse, McLuhan, Elul, and Foucault the answer to the question "Does technology control us?" keeps steering the epistemological debate on technological topics.

As Misa argues, technological determinism remains quite popular and it is easily absorbed by the man in the street. Moreover this billiard-ball model, in which technology comes from outside society and acts upon it, is largely conveyed by popularization articles, mainly in newspapers, journals and TV programs, which commonly refer to the inevitability of a certain technology.

The author's goal is precisely to show, by using historical cases, that "technologies come from within society and are products of on-going social processes" (p. XI), and therefore we can, to a certain extent, choose and change them. This is a major ethical and epistemological issue that is too often ignored.

Unlike other relevant books on this topic, Misa uses a historical longue durée driven approach to make his claim and to persuade his readers. As mentioned above, he begins with the powerful courts of Renaissance Europe and their pensioners, Leonardo da Vinci, Galileo, Gutenberg. The desire for visibility and power, made this period a time for technologies directed to "warfare, city building, courtly entertainments, and dynastic displays" (p.13). Chapter 2 discusses technology during the 16th and 17th centuries' commercial expansion, centered on the Dutch case. The deep relation between technologies, such as boat building or textiles, and economic growth, nourishes a "set of wealth-creating technologies and techniques" (p.57). Chapter 3 focus on one of the most studied periods of European history, the industrial revolution, with its array of industrial technologies. Misa captures the massive changes that took place in England through the "geographies of industry" (p.59) based on three cities — London, Manchester and Sheffield — which identify three distinct industrial realities. Chapter 4 approaches the topic of technology and empires, using as main example the English Empire. Technologies of the land (railways, telegraphs, roads, harbors) were the heart of the notion of "civilizing mission", fulfilling their destiny as "instruments of Empire". (p.97), Chapter 5 tackles the rise of technoscience, highlighting the importance of "system-stabilizing industrial scientists" (p.157), who substituted the 19th century individual genius. Chapter 6 draws from Misa's research and interests on cities as a kind of "urban machines", pointing out how new industrial materials shaped the urban landscape, allowing new experiences in architecture and urban design. Chapter 7 focuses on the powerful influence of military interests in the development of 20th century technologies, ranging from high technology military funded solid-state electronics to the "means of destruction" (p.190), that is, weapons. Chapter 8 deals with globalization using the same perspective as for technology itself, i.e., analyzing it as a historically built phenomenon, with a life time which will eventually end, but that, nevertheless, influences the way "people think about technology and culture" (p.259).

The last chapter goes back to Misa's initial claim against technological determinism. It is an excellent wrap-up, covering some of the major questions that always come to the surface when dealing with the history of technology, based on the data of the previous chapters: what is technology? Which is the extent of the relationship between technology, science and economics? What is technology good for? How does technology change society?

Leonardo to the Internet addresses different publics, ranging from the academic milieu to the general interested public. It is written in an accessible way, yet precise; the narrative easily

catches the reader, but the historical information is never neglected; the author manages to keep his engagé posture when raising and discussing hot topics, but he is never biased.

As a potential textbook, Leonardo to the Internet has different levels of reading: it is a very good first introduction to history of technology, putting the production and consumption of technology in a social perspective since the beginning; it is mandatory for students already acquainted with the basics in history of technology, enabling them to thicken their approach to the multifaceted relation between technology and society.

Overall, Leonardo to the Internet: Technology and Culture from the Renaissance to the Present is a brilliant and stimulating book, easily read and yet full of ideas and arguments that will nourish the readers' spirit for a long time.

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